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THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

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THE CHEMICAL NEWS.

VOLUME LIII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1362.—JANUARY 1, 1886.

SCIENCE IN THE LAW-COURTS.

In *The Journal of Gas Lighting* for December 22nd we find an article entitled "The Institution in the Strand." We have certainly no proof that the writer is referring to the discussion raised by *Nature* and continued in the CHEMICAL NEWS; but that he should have selected the present time for making known his opinions is, at least, a curious coincidence. His object seems to be a defence of our present system of coming at the truth, or of something which may serve in its stead, whenever a scientific or a technical issue is raised in the law-courts. He considers the new Courts of Justice as being "besides the Forum of the nation its supreme Temple of Arts, Sciences, Literature, and Humane Culture!" Lest we should be suspected of laying too great emphasis upon a single passage, detached possibly from modifying clauses, we make further citations:—"This building in the Strand is more of an educational institution than the Royal Society, the British Association, the Institution of Civil Engineers, and all the other learned societies of the kingdom put together." And again:—"Truly the greatest teaching university in the world is this in which there are no professors, tutors, or classes, and where everybody is admitted to learn as much as he likes or can retain of the instruction provided at other people's expense." In developing this astounding claim the writer displays what, to us at least, appears an utter misconception of the functions and the results of our learned societies and our scientific journals, as well as of the character and the habits of scientific men. At the same time, by admissions which he makes, not reluctantly but gleefully, he confirms our view of the necessity for a thorough change.

In support of the charges which we bring we must point out that the Royal Society and "the other learned societies" are not, in any legitimate sense of the word, "educational institutions." Their function is not to diffuse or to popularise knowledge, but to discover what has never been known before. Each paper read before them is a step—great or small—in this direction. Now, in technical trials, the law-courts deal and can deal only with inventions,—special applications of what is already known. New discoveries are never announced from the witness-box. Says the writer:—"The law-courts after all are the scenes where the greatest triumphs of science are placed within the mental reach of the student." Nothing of the sort: the highest generalisations, epoch-making researches, do not come within the purview of the courts at all. Whoever heard of the doctrine of organic evolution, the atomic theory, the cosmogony of Laplace, the law of continuity, the conservation of energy, or the like, being bequibbled in a court for the edification of a bewildered jury? What occupy the attention of courts are incidental matters, such as telephones, torpedoes, and gas-engines—to take the writer's own instances—things which, however grave in a pecuniary sense, are but as the crumbs that fall from the table of science.

The writer considers that "the most striking difference between the handling of technical subjects in the law-courts and in meetings of learned societies is the length of time considered necessary in these cases." True, but this difference is due not to the thoroughness of the courts, but to a circumstance which escapes the writer altogether. A *savant* reading a paper before a learned society speaks of a subject with which he is thoroughly acquainted at first hand. He speaks to men familiar with the same kind of researches,—men who know how the new discovery announced fits in with what is already established, and who can judge of the value of the evidence adduced. In the law-courts all this is reversed; everything has to be explained to men who have little or no previous knowledge of the subject, and whose training unfits them for its right appreciation.

Let us note the derogatory opinions here put forward concerning scientific men:—

"The great man may ordinarily, in his orations and papers, take advantage of his position and reputation, and circulate rubbish that would ruin an unknown speaker; but when once he is fixed by the keen eye of Mr. Attorney-General, or some of his professional brethren, he must talk sense, if he can, like any other man."

Or again:—"The writer of a paper is allowed to take up any position that pleases him, and to say as much or as little as he thinks best for the support of his own views; and after all his hearers are under a certain obligation to him, which generally disposes them to handle him gently."

Surely the writer of the article before us ought to know that any statement made in the Transactions of our learned societies at once goes the round of the civilised world, and is tested and re-tested in a hundred laboratories,—an ordeal far more searching than any verbal cross-examination. And if the fact cannot be verified, or if the inference cannot be maintained, the refutation never fails to be published. To "circulate rubbish," ordinarily would prove a hazardous experiment for the most eminent.

One more quotation, and we have finished:—"The pleasure becomes rapt excitement when . . . the leader on the other side calmly takes the Professor back over his statements, and, regardless of his agonised writhings, makes him confess to an unwarranted assumption here, and a blunder there, and a slip of memory in half-a-dozen places."

A main difficulty with which the expert has to grapple

is that frequently a large part of the evidence by which he reaches his conclusions cannot be expressed in words, though it could easily be pointed out to another expert in consultation. Those "unwarranted assumptions, blunders, and slips," of which our unknown friend speaks, are simply the outcome of the system of examination and cross-examination. Let this system be done away with,—let experts be no longer the partizans of the litigants, but the impartial advisers of the Court,—and those unseemly exhibitions which throw our friend into "rapt excitement" will be at an end, and the "tremendous cost" to the litigants will be seriously reduced.

POTASSIUM CHLORIDE AS A PLANT POISON. ESSENTIAL ELEMENTS OF PLANTS.

By J. M. H. MUNRO.

ONE of the most interesting points in Mr. Jamieson's article on "The Essential Elements of Plants" (CHEM. NEWS, vol. lii., p. 287), is the proof, incidentally afforded by some of his experiments, that potassium chloride may act as a plant poison. Mr. Jamieson appears to have experimented for three successive years on the application of different potash salts to peas and turnips. In the first year the only striking result was produced by potassium chloride, which absolutely reduced the yield to nil in each case; potassium carbonate and sulphate, on the other hand, appeared to be beneficial, since larger crops were produced than when potash was withheld altogether. In the second year the peas again suffered severely from the action of potassium chloride, but the turnips largely benefited from this and from the other potash salts tried. In the third year potassium chloride produced strikingly good results on both peas and turnips, in common with the other potash salts. In the cases where potassium chloride was injurious, Mr. Jamieson tells us that "the plants were actually killed, the symptoms being such as directly pointed to the action of free chlorine. The leaves were markedly blanched throughout in an early stage of growth, and ultimately the plants died"—and then follows theorising to the effect that "decomposition of the potassium chloride had taken place, probably within the plant, the plant seizing the potassium which was essential to it, and liberating chlorine, which exerted its bleaching and poisonous influence." In Mr. Jamieson's 1882 Report to the Sussex Association these theories are pursued further. Nitrate of soda having been found efficacious—in one or two cases—in counteracting the injurious influence of potassium chloride, this result is "explained by its soda neutralising the chlorine." Lime, which one would think as capable—or incapable—of "neutralising the chlorine" as soda, does not answer, because "successful counteraction means liberation of the counter-actor within the plant, and this simultaneously with the substance to be counteracted." "The useless matter, soda and chlorine, at once uniting, form harmless common salt." "Experience and experiment both seemed to indicate that black matter of soil is able to counteract that injurious action" (of potassium chloride). This is explained by the hydrogen of organic matter uniting with the chlorine, the hydrochloric acid thus formed "neutralising itself by lime or by other base at hand."* Acting on the hydrogen theory Mr. Jamieson dressed a plot with dextrine, to supply hydrogen and counteract the liberated chlorine—which it did not do. It gave, however, a transient deep green colour to the young leaves, which again is explained as possibly the effect of "unusually active" or "nascent" nitrogen liberated from nitrates by the action of soil bacteria in presence of the dextrin. This reduction of nitrates, pointed out by Gayon and Dupetit, takes place with extreme ease and rapidity under certain circumstances, as I have had repeated occasion to verify for myself, but as I do not know so much about the "unusually active" properties of the liberated nitrogen as Mr. Jamieson appears to, I have always regarded this reaction as one of the most serious causes of nitrogen being absolutely lost to the soil.

Whilst I cannot agree with Mr. Jamieson in attributing the blanching* and reddening of turnip leaves to chlorine and free acid liberated within the plant, and am unable to follow him in any of the ideas I have quoted above, the *fact* of the occasional injurious action of potassium chloride is certainly an interesting one. A striking instance of it occurred in some experiments on potatoes which I conducted last summer (1885), and may be placed on record here. The plots were on stiff soil at Kingswood, Gloucestershire; and in a field almost immediately adjoining excellent experimental crops of potatoes had been grown, in 1883 and 1884, with a mixed manure containing potash salts (kainite).—(*Agricultural Gazette*, October, 1884.)

Last summer the object in view was to test certain sewage manures in comparison with certain standard fertilisers. The sets were planted on March 17th, 3 feet apart each way, and partially covered with soil. A weighed quantity of manure was applied to each set on March 23rd, and the covering completed. The season was a very dry one in the early part, and the crop was consequently deficient in weight; the tubers were dug and weighed up at the end of September. Briefly summarised the results were as follows:—

39 sets, each manured with 3 ozs. Peruvian guano, gave 114 lbs. tubers (average of five rows).
39 sets, each manured with 2 ozs. cod-fish guano and potash, gave 102 lbs. tubers.
39 sets, each manured with 8 ozs. dried sewage sludge (Coventry), gave 86 lbs. tubers.
39 sets, each manured with 1 oz. herring fish guano and potash, gave 84 lbs. tubers.
39 sets, each manured with 2 ozs. "ferrous superphosphate," gave 82 lbs. tubers.
39 sets, each manured with 4 ozs. dried Coventry sludge, gave 76 lbs. tubers.
39 sets, each manured with 8 ozs. "native guano," gave 74 lbs. tubers.
39 sets, each manured with 1 oz. cod-fish guano and potash, gave 72 lbs. tubers.
39 sets, unmanured, gave (average of four rows) 64 lbs. tubers.
39 sets, each manured with 2 ozs. dried Coventry sludge, to which 20 per cent of potassium chloride had been added, gave no tubers. Only one or two plants appeared above ground, and these eventually dwindled away and died.

There are two curious circumstances in this case. One is that the herring and cod-fish guano, as sent out by Messrs. J. Jensen and Co., contains 12 to 40 per cent of potash, chiefly or partly in the form of chloride, yet these manures produced healthy plants and good crops. The other noteworthy circumstance is that the manure called "ferrous superphosphate" was in effect a mixture of calcium sulphate, monocalcic phosphate, and ferrous sulphate.

* Once or twice in using sulphate of potash, plants with sickly leaves were produced "reddened as if by free acid," thus "confirming the evil tendency of liberated sulphuric acid."—One does not quite see why sulphuric acid should not "neutralise itself by lime or other base at hand" as easily as hydrochloric acid.

* Blanched or variegated leaves generally imply the non-formation of the colouring-matter, which may be brought about by various causes. Salts of zinc, for example, are usually poisonous to plants, and the first symptom is a bleaching of the leaf tips. I have seen even oxide of zinc kill down all the foliage of a plant (*Viola tricolor*), and the new shoots and leaves which were at length produced, and which survived after a severe struggle, were half of them white. In another experiment a hardy plant of wood sorrel growing in a flower-pot was completely killed by a dose of sulphate of zinc. After some time 5 grains of wheat were sown in the earth of the same flower-pot; the plants all germinated and grew to the height of an inch or so, but were perfectly colourless, and died off because the formation of the green colouring matter was prevented by the [illegible].—J. M. H. M.

containing about 12 *per cent of green vitriol*, yet this, far from poisoning the plants, proved to be a good manure, and gave one of the best crops (considering that it was the only non-nitrogenous manure employed). The manures were in every case carefully distributed amongst the surface soil, and were separated from the tubers by an intervening layer of unmanured soil. I was prepared to expect a fair result from the "ferrous superphosphate," but I do not understand the action of the potassium chloride.

To turn to another subject. Mr. Jamieson now foreshadows "the exclusion of sulphur, magnesium, and calcium from the list of plant essentials," mainly on the strength of certain experiments recorded in his Report for 1882 (the *only* analyses quoted appear to be taken from that Report), and continued with less striking results in 1883 and 1884. Good turnips were grown in sand "practically destitute of plant food," notwithstanding that sulphur, calcium, and magnesium were omitted in turn from the manure used. But the turnips thus grown contained as much calcium and magnesium as when these elements were supplied in the manure, so that the sand was at any rate *not* practically destitute of these two substances. One can only agree with Mr. Jamieson (1882 Report) that "the plants manured without lime and magnesia had succeeded in imbibing lime and magnesia, and all inferences regarding these elements must be passed over in the meantime"; and with the further opinion expressed in the 1884 Report (p. 33), "it appears from this set of experiments that lime is required: as was frequently pointed out, the evidence against lime was not strong from the first." Why, then, does Mr. Jamieson now consider that these same experiments "foreshadow the exclusion" of lime and magnesia from the list of plant essentials? As regards sulphur, two turnips only—grown with a manure from which sulphur was excluded—appear to have been analysed: one contained sulphur, although less than the normal proportion; the other is said to have contained none. The only analysis I can find of the sand in which these roots were grown is on page 1, Appendix, of the 1882 Report, and we there find the proportion of sulphuric anhydride stated as 0·010 per cent of the dry soil, or 1 part in 10,000. As long ago as 1864 Berrier and Lucanus raised very fair plants of oats in well water containing less than this proportion of sulphur (7·5 parts SO_3 in 100,000), but no one has hitherto thought of inferring from this experiment that sulphur is non-essential to plant growth.

College of Agriculture, Downton, Salisbury.

A THEORY OF THE CONNECTION BETWEEN THE CRYSTAL FORM AND THE ATOM COMPOSITION OF CHEMICAL COMPOUNDS.*

By WILLIAM BARLOW.

IT is not my intention to discuss the generally received atomic theories, or to offer any new suggestions as to the nature of atoms. I shall merely require the following hypotheses as a basis for the theory I am about to submit to you:—

1. That atoms, or detached centres of force, exist, and that they in some cases attract, in some cases repel, one another.
2. That the atoms of a crystallising body, and by this I mean the atoms of the chemist, are kept in their places by the system of mutual attractions and repulsions which they exercise on one another.
3. That the repulsion or attraction, as the case may be, of any two atoms is some function of their distance, or mean distance, apart, and is irrespective of any linking together of particular individual atoms in molecules, if such ever really obtains.
4. That two atoms which when within a certain mean distance of one another are repelled, are attracted when at some greater distance apart.
5. (And this is the foundation-stone of my theory) that the attractions or repulsions exercised by *different kinds of atoms* are *different functions* of the distance.

These are my hypotheses: the following proposition is based upon them:—

If the different kinds of atoms composing a fluid mass are present in such numerical proportions as to admit of a uniform compact symmetrical arrangement in space of the different kinds of atoms with respect to one another, then the occurrence of alternate condensation and rarefaction of portions of the mass, such as is produced by passing wave-movements (those propagating sound, for instance), will everywhere produce an arrangement of the atoms having some degree of approximation to such a symmetrical arrangement.

The proof I have to offer is the following:—

It is evident upon the hypotheses I have stated that when any portion of a fluid mass composed of different kinds of atoms experiences condensation or rarefaction the atoms will from time to time take up relative positions such that the various attractions and repulsions subsisting at the moment form a system in equilibrium.

And since, by hypothesis, the attractions or repulsions exercised by *different kinds of atoms* are *different* functions of the distance, their arrangement will not generally be similar for different degrees of condensation.

If, however, the attraction or repulsion exercised by a certain atom on another atom is balanced by the attraction or repulsion of a similar atom *placed opposite at an equal distance*, the similar approach or recession of the two similar atoms will cause the forces they respectively exert on the third atom to neutralise one another, whatever the nature of the laws according to which the forces of attraction or repulsion change with change of distance.

To give a simple illustration. Suppose these five balls (Fig. 1) represent five atoms of some system in equilibrium (different kinds of atoms being indicated by different coloured balls), and that they have the symmetrical disposition you see; and suppose that through the passage of some wave of alternate condensation and rarefaction the distances apart of the atoms are similarly changed, that opposite atoms similarly approach, or similarly recede, from the central atom, then it is clear that, so long as the symmetry prevails, any change in attraction or repulsion produced by the alteration in position of one atom will be compensated by the similar change produced by the simultaneous alteration in position of the opposite atom.

But this will only be the case when the symmetrically placed opposite atoms *are of the same kind*. If two atoms *of a different kind* simultaneously approach a third atom in opposite directions, we shall, by hypothesis, have dissimilar changes in the degree of attraction or repulsion exercised by the two opposite atoms, *and the central atom will move nearer to one or other of them*, and the further the departure from a symmetrical arrangement the greater the change of relative position of the atoms will be.

It follows that the more symmetrically the various kinds of atoms of a liquid mass are placed with respect to one another, the less change of relative arrangement they will undergo under the condensation or rarefaction produced by passing waves.

Now, from the fact of the atoms experiencing less change of position the more symmetrically they are disposed, it evidently follows that the most symmetrical and compact distribution of the atoms in space possible will be the system of stable equilibrium towards which they will continually approximate under the re-arranging agency of the alternate condensations and rarefactions, and the more vigorous the re-arranging agency is the nearer the approximation to this symmetrical system of arrangement will

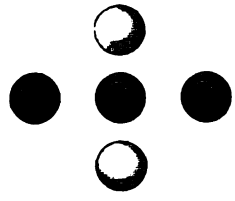
* A Paper read before Section B, British Association, Aberdeen Meeting.

be. The proposition which I just now submitted is therefore established.

In cases where more than one symmetrical compact system of arrangement of the same atom proportions is possible, it is reasonable to conclude that the system which, under the conditions prevailing, *gives the most stable equilibrium of the forces of attraction and repulsion* will be the symmetrical system towards which the atoms will approximate.

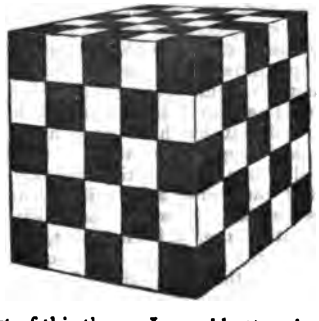
My theory, based on the foregoing, of the origin of the symmetrical disposition of the matter of crystals,—a disposition which is revealed both by their forms and their

FIG. 1.



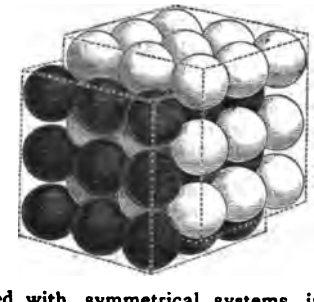
properties—is: *That liquid matter in the act of crystallising, just before solidification takes place, has the chemical atoms of different kinds which compose it symmetrically arranged in space with respect to one another, and that this symmetrical disposition of the atoms is the direct consequence of the continual condensation and rarefaction of different groups of the atoms of the mass produced by the passage of waves (such, for example, as those which propagate sound), and is that disposition which gives the greatest stability under the conditions prevailing.*

FIG. 2.



In support of this theory I am able to point out several cases in which, if the particular numerical proportions of different atoms occurring in certain bodies are arranged in the most symmetrical and compact manner possible, we

FIG. 3.



are furnished with symmetrical systems in complete harmony with the respective crystal forms of the bodies.

First, I will take the very simple case of compounds composed of two kinds of atoms in equal numbers.

There are but two systems of arrangement of *equal* infinite numbers of two sorts of *small* bodies in space which are completely symmetrical, and in which each sort is evenly distributed through space, the perfect evenness of distribution being evidenced by the property that when the centres of the bodies nearest to any body of the system are joined the solid thus outlined has its edges equal.

These two symmetrical systems may be exhibited in the following manner:—

Take a number of equal cubes of two different colours, say black and white, and proceed to build them into a con-

FIG. 4.

tinuous mass in such a manner that no cube shall touch any other cube of the same colour except at its edges, or, in other words, so that a section of the mass parallel to either of the three directions of the faces will present the appearance of a chess-board (Fig. 2); then—

1. If, disregarding the distinction of colour, we suppose a number of similar small bodies of one sort placed at the centres of all the cubes, and a number of similar small bodies of another sort placed at all the cube angles, we have an example of one of the two systems.
2. If we suppose a number of similar small bodies of one sort placed at the centres of the black cubes, and a number of similar small bodies of another sort placed at the centres of the white cubes, we have an example of the other system.

Here are two stacks of balls so arranged that the centres of the balls in one stack (Fig. 3) have the disposition of the first of these symmetrical systems, and the

FIG. 5.

centres of the balls in the other stack (Fig. 4) the disposition of the second. Both systems are symmetrical with respect to three axes at right angles to one another, and are evidently in harmony with a cubic form.

Now we have the important fact that, as a rule, compounds containing an equal number of atoms of two kinds crystallise in cubes. As instances I may mention potassic chloride, potassic bromide, potassic iodide, sodic chloride, sodic bromide, sodic iodide, cæsic chloride, plumbic sulphide, argentic chloride.

Mercuric sulphide which crystallises in six-sided prisms is an apparent exception, but if we were guided by the gaseous volume of mercury in determining its atomic weight we should have two atoms of mercury to one of

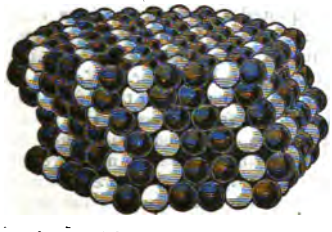
sulphur in this compound. Other apparent exceptions are zincic oxide crystallising in six-sided prisms, cadmium sulphide, and glucina.

The facts as to compounds of equal numbers of two kinds of atoms are therefore seen to be mainly in harmony with the theory I have submitted.

Next as to compounds composed of two kinds of atoms present in the proportions 1 : 2.

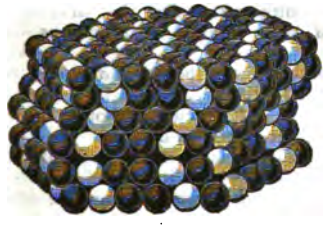
Infinite numbers of two sorts of similar small bodies present in the proportions 1 : 2 can evidently be arranged

Fig. 6.



in the same plane with perfect symmetry in the way I have here shown (Fig. 5),—one kind of body being placed at the centres of the black balls, the other at the centres of the white,—and series of these plane systems can be ranged parallel to one another in a symmetrical manner in various ways. There are, however, but six different ways in which a number of similar plane systems of this

Fig. 7.



kind can be placed so as to give complete evenness of distribution, as well as complete symmetry, each small body of these six systems being equidistant from the twelve bodies nearest to it.

These six systems are shown by the centres of the balls in these six stacks (Figs. 6, 7, 8, 9, 10, 11). All the six systems have the vertical distances between the plane systems the same.

Fig. 8.

In four (Figs. 6, 7, 8, 9) the arrangement of the different colours is symmetrical about a vertical axis or direction, balls of one colour forming staircase spirals about symmetrically-placed lines having this direction. In the other two (Figs. 10 and 11) the arrangement of the different colours is symmetrical with respect to three planes at right angles to one another.

Disregarding the difference of kind of the small bodies symmetrically arranged, we have two kinds of symmetry only; these three systems (Figs. 6, 7, and 10), when considered apart from the differences of colour, being identical; and these three (Figs. 8, 9, and 11) also identical.

Now at first sight we might suppose that the atoms of the compounds under consideration should have the arrangement of one or other of these six systems; but a moment's consideration of our hypothesis, that the attractions or repulsions exercised by the different kinds of atoms are different functions of the distance, shows us that the distance from an atom to the atoms next around it in one of the plane systems (Fig. 5) will not ordinarily be the same as the distance from an atom in one plane system to one of the nearest atoms in the next plane

Fig. 9.

system; for each atom will be exposed to different systems of repulsion and attraction in the two different directions. While, therefore, we shall expect the atoms of the compounds under consideration to be arranged approximately according to one of the six systems depicted, *so far as their situation relatively to a vertical axis is concerned*, we shall not look for the distances between the plane systems to be as in these six systems before you, but shall expect these distances, though equal to one another throughout the same system, to be different in different cases, according to the nature of the two kinds of atoms forming the compound.

Fig. 10.

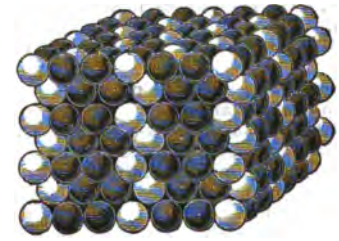
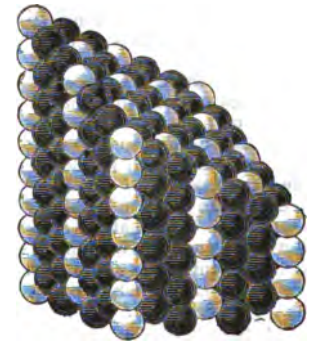


Fig. 11.



In other words, the arrangement of the atoms of a body composed of two sorts of atoms present in the proportion 1 : 2 may be expected to be such that, instead of its being depicted by one of these six stacks of equal spheres, it would be depicted by a similarly-formed stack composed of similar and similarly-placed spheroids or ellipsoids. In

the cases which follow those four of our six typical systems which are symmetrical about a single vertical axis (Figs. 6, 7, 8, 9) the arrangement would be depicted by a stack of similar prolate or oblate spheroids placed with their axes vertical. In cases which follow the remaining two systems (Figs. 10 and 11), whose symmetry is trimetric, the arrangement would be depicted by a stack of similar and similarly-placed ellipsoids. The kind of spheroid or ellipsoid to be employed will depend on what kinds of atoms are associated in the compound.

If we make the natural supposition that in all cases the different atoms have the same identical symmetrical disposition with respect to each of the different directions of *corresponding* crystal faces, the six types of symmetrical arrangement I have thus indicated are in harmony with various different symmetrical crystal forms.

Thus the colours in these two stacks (Figs. 6 and 7) have a perfectly hexagonal symmetry about a vertical axis, and therefore suggest a regular hexagonal prism terminated possibly by a regular hexagonal pyramid, the inclination of the pyramid faces to the prism faces depending on the kind of spheroid which has to be employed in place of spheres.

The arrangement of the colours in these two (Figs. 8 and 9) suggests a hexagonal prism terminated by trihedral summits, or by hexagonal pyramids with alternate faces similar.

The arrangement of the colours in these stacks (Figs. 10 and 11) suggests trimetric right prisms.

Neither of the six types is in harmony with the cubic system.

Now most of the compounds of the kind under consideration have their crystal forms in harmony with one or other of our six types.

Thus water, OH_2, crystallises in six-sided prisms or in rhombohedra.

Quartz, SiO_2, crystallises in six-sided prisms with pyramids.

Titanic oxide, TiO_2, in square prisms, in right rhombic prisms, and in acute octahedra.

Cuprous sulphide, Cu_2S, in six-sided prisms.

Lead chloride, $PbCl_2$, in six-sided needles.

Lead dioxide, PbO_2, in six-sided prisms.

And mercuric sulphide, which if—as already remarked—we estimate the atomic weight of mercury according to its gaseous volume, we shall write Hg_2S, crystallises in six-sided prisms.

About the only compound regarded as consisting of two kinds of atoms in the proportions 1 : 2 which crystallises in the cubic system is calcic fluoride (fluor-spar), and it is interesting to notice that a different atomic weight for calcium which would enable us to write calcic fluoride CaF, and thus add it to the list of compounds containing equal numbers of two kinds of atoms, would also enable us to trace a symmetrical system of arrangement for another compound of calcium, Iceland spar, in accordance with its crystal form: this I hope to show you presently.

In the case of one of the compounds I have just mentioned, quartz or rock crystal, the optical property possessed by this body of rotating the plane of polarisation of a polarised ray has been argued to indicate a spiral arrangement of the atoms, right-handed in some specimens, left-handed in others, this conclusion being supported by the well-known experiment of producing similar rotation by means of a combination of thin laminæ of mica arranged in the manner of winding stairs. In connection with this it is interesting to notice the beautiful spirals traced by the black and white balls in some of our six systems (Figs. 6, 7, 8, and 9).

From the rhombohedral symmetry of quartz I suppose that the two systems in which the smaller spirals occur (Figs. 8 and 9) are the types of the pair of systems according to which this substance is built up.

(To be continued).

ON THE ESTIMATION OF NITROUS COMPOUNDS IN VITRIOL.

By THOMAS BAYLEY.

In a paper on the "Applications of the Nitrometer," read by Mr. A. H. Allen before the Birmingham Section of the Society of Chemical Industry, and published in the *Journal* for March last, p. 178, it was stated that erroneous results might be obtained under certain circumstances in the assay of nitrous vitriol by the nitrometer.

Mr. Allen suggested that the solubility of nitric oxide in the acid liquid floating upon the mercury in the nitrometer-tube may, and does, lead to low analytical results, and he quoted some observations I had made at his request as evidence in favour of his contention.

In a communication subsequently published in the *Journal*, vol. iv., p. 447, Professor G. Lunge impugns the accuracy of my experiments, and therefore the validity of Mr. Allen's deduction from them. He also makes the assumption that the supposed inaccuracy was due to imperfect cooling of the gas before measurement.

One would have thought that before promulgating such an explanation as this and rejecting our general conclusions Professor Lunge would himself have repeated the experiments; but he appears to have preferred to work in an entirely different direction. He shook together pure sulphuric acid and pure nitric oxide in a nitrometer over mercury, and by these means demonstrated the practical insolubility of nitric oxide in sulphuric acid.

This result confirms my own experiments, and agrees with the general testimony of previous observers; but Professor Lunge appears to have overlooked the all-important fact that the liquid floating upon the mercury contained in a nitrometer after the shaking *is not pure sulphuric acid*, but a solution of mercurous nitrate in sulphuric acid.

Now the ordinary text-books and works of reference (*e.g.*, "Watts's Dictionary," "Gmelin's Handbook," &c.), credit the sub-salts of mercury and other metals with the power of dissolving nitric oxide gas.

I have repeatedly shaken nitrous vitriol, and also pure sulphuric acid mixed with nitric acid, in the nitrometer until the evolution of gas was complete, submitted the gas to ample cooling, re-shaken, and re-cooled several times, and then let the gas escape. The tube being now full to the tap with liquid, and free from gas, I have shaken it again to assure myself that no further disengagement of nitric oxide could be induced. I then have added water equal in volume to the acid liquid, and have invariably obtained a further liberation of gas, possessing the properties of nitric oxide.

Now Professor Lunge says:—"If Bayley's experiment were to be trusted, even the dilution recommended by Allen would not be sufficient, for strong oil of vitriol at 1·84 diluted with two-thirds its volume with water, yields acid of 1·62 sp. gr., at which strength Bayley asserts it to retain still 0·5 c.c. of gas."

But pure sulphuric acid (1·84) when saturated with NO will contain only a mere trace of that body, and hence cannot liberate any appreciable quantity on dilution. But it is a fact that on heating a solution of the nitric oxide in mercurous vitriol effervescence occurs with escape of the gas; and the dilution of vitriol with water generates

	Grms. of $NaNO_3$ per 100 c.c.		
1885.	With H_2O.	Without H_2O.	Difference.
Sep. 2	0·36	0·29	0·07
,, 3	1·08	0·93	0·15
,, 4	0·43	0·36	0·07
,, 5	0·72	0·65	0·07
,, 7	0·54	0·43	0·11
,, 8	0·50	0·43	0·07
,, —..	1·08	1·01	0·07

heat. The dilution of the vitriol also causes a separation of dissolved mercurous salt, and if this salt be the agent causing solution the gas must be liberated when the salt is precipitated. The following experiments were made at my request by a gentleman who is accustomed to make a daily examination of the acid in certain vitriol chambers.

The following are my own experiments:—

Three grms. of pure sodium nitrite were dissolved in a few centimetres of water without loss, and the solution diluted with pure vitriol to 100 c.c. 3 c.c. of the solution liberated 7·8 c.c. of gas; and after addition of 3·5 c.c. of water, a further quantity of 0·5 c.c. of gas. Another sample of pure acid mixed with nitric acid; 2·0 c.c. liberated 7·5 c.c. in the first instance, and a further 0·45 c.c. on dilution with water. A second dilution frequently causes the liberation of further small quantities of gas. In order to confirm these results I adopted a different method of experimenting.

Nitric oxide was prepared by the action of nitric acid (sp. gr. 1·2) on copper ribbon, the gas being washed by means of potash solution, followed by strong sulphuric acid. The nitric oxide was passed through pure sulphuric acid contained in weighed Geissler-bulbs. A trace only of gas was dissolved, 14·678 grms. of pure acid retaining less than 0·001 grm. of NO.* Care was taken to employ carbonic acid gas so as to prevent the admission of air, and consequent oxidation of the nitric oxide.

This experiment having confirmed the insolubility of nitric oxide in strong sulphuric acid, the stream of NO was next passed through a solution of mercurous sulphate in some of the same sample of sulphuric acid. The mercurous solution was made in the nitrometer, and the acid was boiled and cooled before use. In this instance 14·678 grms. of acid gained 0·0098 grm. of NO.

A mercurous solution prepared by directly dissolving mercurous sulphate in strong sulphuric acid gave a similar result, the acid solution being in this case boiled and cooled before use.

THE METHODS OF ANALYSING FERTILISERS

ADOPTED BY THE

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS OF THE UNITED STATES.

INCLUDING THE CHANGES MADE AT THE MEETING AT WASHINGTON, SEPTEMBER 1, 1885, WITH THE RECOMMENDATIONS REGARDING THE WORK OF THE SEASON OF 1885-'86.

THE following extracts from the proceedings of the meetings of the Association at Atlanta and at Washington are published by the North Carolina Experiment Station in a form for convenient reference in the laboratory.

CHARLES W. DABNEY, jun., *Secretary*.

Raleigh, N.C., October 24, 1885.

I. *Extract from Report of Committee on the Method of Determining Phosphoric Acid.*

(Washington Meeting, September 1, 1885.)

In conclusion your committee recommends that the methods of analysis adopted at our last meeting be amended as follows:—

"Before the 'Determination of Phosphoric Acid in Fertilisers' insert the following:—

Determination of Moisture in Fertilisers.

(1.) In potash salts, nitrate of soda, and sulphate of ammonia heat 1-5 grms. at 150° C. till the weight is constant, and reckon water from the loss.

(2.) In all other fertilisers heat 2 grms., or, if the sample is too coarse to secure uniform lots of 2 grms. each, 5 grms. for five hours at 100° C. in an air-bath."

Your committee also recommends that the following addition be made to the description of the Association's methods of determining citrate-insoluble phosphoric acid:—

"The method of extracting 'reverted' phosphoric acid was originally designed for and is applicable only to superphosphates, plain or nitrogenised, and was not intended to be applied to rock phosphates, natural guanos, or any other non-acidulated materials, to test their relative solubility or availability. In case, however, a determination of citrate-insoluble phosphoric acid is required in these non-acidulated goods, it is to be made by treating 2 grms. of the phosphatic material without previous washing with water, precisely in the way above described, except that in case the substance contains much animal matter (bone, fish, &c.), the residue, insoluble in ammonium citrate, is to be ignited with magnesium nitrate."

Your committee further recommends that in all other respects the method adopted at our last meeting (see after this report), for the determination of P_2O_5 in its three states *be rigorously followed during the coming year*. They *specially urge attention* to the following points:—

(1.) The solution of ammonium citrate to be strictly neutral and of the sp. gr. indicated.

(2.) Perfect solution of the phosphate in acid. After boiling with acid, diluting, and decanting, it is well to boil the insoluble residue again with strong acid.

(3.) The magnesia mixture to be added not more rapidly than indicated (one drop per second).—Peitsch, Rohn, and Wagner, *Fres. Zeitschr. f. Analyt. Chem.*, xix., 448.

Since the ignition with $Mg(NO_3)_2$ requires some time and an additional transfer of the material from one vessel to another, which always involves the possibility of mechanical loss, experiments are desirable to determine whether organic matter can be destroyed or made harmless by oxidation in the wet way, by fuming nitric acid or other reagents, in the flask in which the subsequent solution of the phosphate is to be made.

It is also desirable to know to what extent silica passes into solution when phosphates of various kinds are digested in strong acid. A single experiment on "SoCa" gave the writer:—

Total sand and silica	3·92 p.c.
Brought into solution by boiling in strong HCl	0·02 ,,
Brought into soltn. by ignition with $Mg(NO_3)_2$ and adding strong HCl	0·05 ,,

It is also desirable to know just what effect silica in solution has on the determination of P_2O_5 by the molybdate method. The testimony on this point is conflicting. *See* Bertrand, *Jahresb. Ag. Chem.*, xxvi., 318; Lindo, CHEMICAL NEWS, xlix., 1884, 247, *et seq.*; *Bied. Centralbl. Ag. Chem.*, 1884, 642; Atkinson, *Fres. Zeit. f. Analyt. Chem.*, xviii., 447; Jenkins, *Jour. f. Prakt. Chem.*, xiii., 237.

Your committee also express the belief that an annual distribution of samples and comparison of results will be of great use in securing accuracy and uniformity among analysts, and urge on the members of the Association the desirability of promptly analysing and reporting results on samples which they receive.

All of which is respectfully submitted,

E. H. JENKINS,
H. C. WHITE,
W. C. STUBBS.

Washington, D.C., Sept. 1, 1885.

Determination of Phosphoric Acid in Fertilisers.

(Method adopted at Atlanta, 1884. Still in force.)

1. The sample should be well intermixed and properly prepared, so that separate portions shall accurately repre-

* The acid used for this experiment, which was commercially pure, and had probably not been subjected to distillation, contained small traces of copper and iron. The presence of these metals no doubt accounted for the change of tint which the passage of the gas occasioned. Very few samples of acid when submitted to this test remain colourless.

sent the substance under examination, without loss or gain of moisture.

2. *Water-soluble Phosphoric Acid.*—Bring 2 grms. on a filter; add a little water; let it run out before adding more water; and repeat this treatment cautiously until no phosphate is likely to precipitate in the filter. (The washings may show turbidity after passing the filter.) When the substance is nearly washed in this manner, it is transferred to a mortar and rubbed with a rubber-tipped pestle to a homogeneous paste (but not further pulverised), then returned to the filter, and washed with water until the washings no longer react acid with delicate test-paper. Mix the washings. Take an aliquot (usually corresponding to one-third or one-half of a grm. of the substance), and determine phosphoric acid as under total phosphoric acid.

3. *Citrate-insoluble Phosphoric Acid.*—Wash the residue of the treatment with water into a 150 c.c. flask with 100 c.c. of strictly neutral ammonium citrate solution of 1·09 density; shred and add the filter-paper; cork the flask securely; place in a water-bath with constant temperature of 65° C., and digest for thirty minutes with frequent shaking. Filter the warm solution quickly, and wash with water of ordinary temperature.*

Transfer the filter and its contents to a porcelain capsule. Ignite until the organic matter is destroyed; treat with 10 to 15 c.c. of fuming hydrochloric acid; digest over a low flame until the phosphate is dissolved; dilute to 200 c.c.; mix; pass through a dry filter; take an aliquot, and determine phosphoric acid as under total.

4. *Total Phosphoric Acid.*—Weigh 2 grms. into a capsule, add and mix intimately with 4 to 7 c.c. of a nearly saturated solution of magnesium nitrate, dry, ignite gently, if necessary, moisten the residue with nitric acid, and ignite again to destroy all organic matter; add to the residue 15 to 20 c.c. of fuming hydrochloric acid; digest at a gentle heat until all phosphates are dissolved; dilute to 200 c.c.; mix; pass through a dry filter; take 50 c.c. of filtrate; neutralise with ammonia; add about 15 grms. dry ammonium nitrate; and to the hot solution, for every decigrm. of P_2O_5 that is present, 50 c.c. of molybdic solution. Digest at about 65° C. for one hour; filter and wash with ammonium nitrate solution. (Test the filtrate by renewed digestion and addition of more molybdic solution.)

Dissolve the precipitate on the filter with ammonia and hot water, and wash into a beaker to a bulk of not more than 100 c.c. Nearly neutralise with hydrochloric acid; cool, and add magnesia mixture from a burette, slowly (one drop per second), stirring vigorously. After fifteen minutes add 30 c.c. of ammonia solution of density 0·96. Let stand several hours. (Two hours is usually enough.) Filter; wash with dilute ammonia; ignite intensely for ten minutes, and weigh.

5. *Citrate-Soluble Phosphoric Acid.*—The sum of the water-soluble, and citrate-insoluble, subtracted from the total gives the citrate-soluble.

Preparation of Reagents.

1. *To prepare Ammonium Nitrate Solution.*—Mix 370 grms. of commercial citric acid with 1500 c.c. of water; nearly neutralise with crushed commercial carbonate of ammonia, 410 grms.; heat to expel the carbonic acid; cool; add ammonia until exactly neutral (testing for excess both of acid and alkali by aid of delicate red and blue litmus-papers), and bring to volume of 2 litres. Dilute further until the density is 1·09, as tested by the balance or *accurate* specific gravity spindle.

2. *To prepare Solution of Magnesium Nitrate.*—Dissolve 320 grms. of "calcined magnesia" in nitric acid, avoiding excess of the latter; then add a little "calcined magnesia" in excess, and boil; filter from the excess of magnesia, ferric oxide, &c., and bring to volume of 2 litres.

3. *To prepare Molybdic Solution.*—Dissolve 100 grms. of molybdic acid in 400 grms. or 417 c.c. of ammonia of sp. gr. 0·96, and pour the solution thus obtained into 1500 grms. or 1250 c.c. of nitric acid of sp. gr. 1·20. Keep the mixture in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate of ammonium phospho-molybdate. Decant the solution from any sediment, and preserve in glass-stoppered vessels.

4. *To prepare Ammonium Nitrate Solution.*—Dissolve 200 grms. of commercial ammonium nitrate in water, and bring to a volume of 2 litres.

5. *To prepare Magnesia Mixture.*—Dissolve 22 grms. of recently ignited "calcined magnesia" in dilute hydrochloric acid, avoiding excess of the latter. Add a little "calcined magnesia" in excess, and boil a few minutes to precipitate iron, alumina, and phosphoric acid; filter; add 280 grms. of ammonium chloride, 700 c.c. of ammonia of sp. gr. 0·96, and water enough to make the volume of 2 litres. Instead of the solution of 22 grms. of "calcined magnesia," 110 grms. of crystallised magnesium chloride ($MgCl_2.6H_2O$) may be used.

6. *Dilute Ammonia for Washing.*—One volume ammonia of sp. gr. 0·96 mixed with three volumes of water, or, *usually*, 1 volume of concentrated ammonia with 6 volumes of water.

2. *Method for estimating Potash—Extract from the Report of the Committee on Potash.*

(Washington Meeting, September 1, 1885.)

In case the potash is contained in organic compounds, like tobacco-stems, cotton-seed, hulls, &c., it is to be saturated with strong sulphuric acid and ignited in a muffle to destroy organic matter. Pulverise the fertiliser (200 or 300 grms.) in a mortar. Take 10 grms., boil for ten minutes with 200 c.c. water, and, after cooling and without filtering, make up to 1000 c.c., and filter through a dry paper. If the sample have 10 to 15 per cent K_2O (kainite) take 25 c.c. of the filtrate; if from 2 to 3 per cent K_2O (ordinary potash fertilisers), take 100 c.c. of the filtrate. In each case make the volume up to 150 c.c., heat to 100° C., and add drop by drop with constant stirring a slight excess of barium chloride. Without filtering, in the same manner add barium hydrate in slight excess. Filter and wash until the precipitate is free of chlorides. Add to filtrate 1 c.c. strong ammonium hydrate, and then drop by drop a saturated solution of ammonium carbonate until the excess of barium is precipitated. Add now, in fine powder, 5 grms. pure oxalic acid or 0·75 grm. ammonium oxalate. Filter, wash the precipitate free of chlorides, evaporate filtrate to dryness in a porcelain dish, and, holding dish with crucible tongs, ignite carefully over the free flame below red-heat until all volatile matter is driven off.

The residue is now digested with hot water, filtered through a 5 c.m. filter, and washed with successive portions of 2 c.c. hot water until the filtrate amounts to 30 c.c. To this filtrate, after adding 2 drops of strong hydrochloric acid, is added in a porcelain dish 10 c.c. of a solution of 10 grms. of platinic chloride in 100 c.c. of water. The mixture is now evaporated on the water-bath to a thick syrup, treated with 85 per cent alcohol, well rubbed with the stirring rod, washed with 85 per cent alcohol by decantation, collected on a Gooch crucible, washed with 85 c.c. alcohol, afterwards with 5 c.c. ether, dried for thirty minutes at 100° C., and weighed. It is not necessary to check the results by washing out the precipitate and re-weighing the crucible, or by reducing its weight after washing out the potassium chloride. We recommend the continuance of the use of the factor 30·56 for converting K_2PtCl_6 to KCl, and 19·308 for converting to K_2O. We further recommend that the Committee on Potash, which may be appointed for the coming year, distribute at an early date samples of fertilisers to members

* This filtration should not exceed fifteen to twenty minutes in duration, and in difficult cases is best effected by use of a plaited filter of very porous paper or by help of a filter-pump of *moderate* power.

of the Association and others interested, with such recommendations as may seem best suited to secure a thorough trial of this and all new methods which may appear to promise success.

Respectfully submitted,

H. W. Wiley,
W. J. Gascoyne.
Clifford Richardson.

3. *Nitrogen Determination.*

No method for determining nitrogen in fertilisers was adopted by the Association.

ELECTROLYTIC SEPARATION OF ZINC AND CADMIUM.

By S. Eliasberg.

The separation of these metals by gravimetric methods does not, as is well known, rank among the easier tasks of analytical chemistry. An electrolytic method was proposed in 1880 by A. Iver (*Bull. Soc. Chim. de Paris*), and requires consideration. He mixes the acetic or sulphuric solutions of the metals with 2 to 3 grms. sodium acetate, adds a few drops of acetic acid, applies heat, and electrolyses by means of two Daniell elements. The author has examined this method at the request of Prof. Classen, and has found that the heat must be kept up during the entire duration of the electrolysis, as the cadmium is not completely deposited from a cold solution. The statement of the strength of the current as that of two Daniell elements is not sufficiently precise, as an equal number of elements of the same kind do not always give currents of the same strength according to the strength of the acids, &c.

It has frequently happened that two Bunsen elements gave off from 10 to 20 c.c. detonating gas per minute, according as they were more or less carefully prepared. This point requires particular prominence, since the author has not succeeded in getting good results with two Daniell elements which gave off 0·2 c.c. detonating gas per minute: the current was too feeble to throw down all the cadmium.

The strength of a current had to be ascertained at which all the cadmium was deposited, but not all the zinc. The most suitable current was found to be one giving off 0·5 to 0·6 c.c. detonating gas per minute. It was obtained by means of two Bunsen elements with the introduction of a resistance.

As to the concentration of the solution nothing was laid down by Iver. According to the author's experience the capsule must not contain more than 90 c.c. When this is the case good results are generally obtained in six hours (not three to four, as stated by Iver). Sometimes, however, zinc oxide separates out in the capsule at the margin of the liquid, when the analysis is lost.

In the separation of these metals the author uses soluble double oxalates. He proceeds as follows:—

The metallic oxides are dissolved in hydrochloric acid, evaporated to dryness, mixed with 8 to 10 grms. potassium oxalate and 2 to 3 grms. ammonium oxalate, diluted to about 100 c.c., heated almost to a boil, and submitted to electrolysis, keeping up the temperature but avoiding ebullition. The liquid does not evaporate away, as the steam for the most part condenses on the glass cover and drops back. If a considerable loss by evaporation is perceived water may be added.

The strength of the current was 0·01 to 0·015 ampère, the evolution of detonating gas being 0·1 to 0·15 c.c. per minute. In six to seven hours the separation is complete. The cadmium separates out chiefly with a smooth surface, but partly in a crystalline form. If more than 0·15 grm. of metal are taken a longer time is requisite.—*Zeitschrift für Analytische Chemie.*

NOTICES OF BOOKS.

Physico-Chemical Constants: Melting- and Boiling-point Tables. By Thomas Carnelley, D.Sc (London), B.Sc. (Vict.), F.C.S., Professor of Chemistry in University College, Dundee. London: Harrison and Sons.

No kind of physical or chemical research is at once so useful to the scientific world, so laborious, and so immediately unremunerative to the experimentalist, as the determination of constants. Whilst requiring skill in manipulation, acuteness in detecting and eliminating sources of error, and above all an unlimited fund of patience, the results meet with little acknowledgment. The work, of which the first volume lies before us, is a gigantic undertaking. The author's original object was to trace the connection—if any—between the chemical composition and the melting- and boiling-points of inorganic bodies. For this purpose many determinations became necessary, and new processes had in many cases to be elaborated. Gradually the investigation was also extended to organic substances—a task which, as the author informs us, and as we can well believe, has taken eight years of almost continuous labour.

The present volume contains nearly 19,000 separate determinations of melting- and boiling-points, and the forthcoming volume will bring the number up to 50,000.

Dr. Carnelley's objects have been to prepare as complete a list as possible of all known melting- and boiling-points, indicating, in the frequent case of discrepant authorities, which determination is the most exact; to state, as fully as possible, the constitution of each substance; to adopt a convenient system of arrangement; to give the authority along with reference to original memoirs; and, to meet the requirements of those who have not ready access to large libraries, references as far as possible to "Watts's Dictionary" and to the *Journal of the Chemical Society*.

The discrepancies in certain cases are remarkable, and are doubtless due either to the selection of impure specimens or to the use of imperfect methods. As an instance we may mention boron. According to Mott this substance fuses at 300°, whilst Roscoe and Schorlemmer say "above a white heat," Odling "at an intense heat," and Dépretz "in the electric arc." Again, uranium—according to Mott—fuzes at 207°, whilst Roscoe finds it "fusible only before oxyhydrogen blowpipe."

Concerning gallium, also, authorities differ. Lecoq de Boisbaudran gives its fusion-point as 30·15°, whilst Pictet places it as low as −20°, which Dr. Carnelley queries. In such cases the author italicises the value which appears to be the most accurate.

The volume is furnished with a table of contents, with explanatory notes, a list of abbreviations, and a catalogue of references. Concerning the high value of this work, both to the theoretical investigator and to the technical chemist, no two opinions can prevail.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I cordially endorse the views expressed by your correspondent signing himself "A Practising Fellow of the Institute," printed on page 318.

It is quite time that the members of the Institute generally should understand to what the Council have committed them, so that they may either give the action of the latter a deliberate endorsement or may elect those who will more accurately represent their views.

The Council have decided that future Members and

Associates of the Institute must have studied for three years in one of the score or so of "Colleges" the curriculum of which is regarded as satisfactory. This decision was arrived at deliberately, although it was pointed out during the discussion that such a regulation practically prohibited members of the Institute who were not connected with those colleges from taking apprentices with a view to their subsequently joining the Institute. Such a decision, amounting practically to a boycotting of a considerable number of members of the Institute, could only be justified if it could be shown that it was impossible to acquire an adequate knowledge of the profession in a private laboratory, which is far from being the fact.

The Council attach importance to three main subjects: mathematics, physics, and chemistry. Of these, surely no one will contend that mathematics cannot be adequately studied outside the walls of a "College," and of all subjects it is the one which most readily admits of a satisfactory examination-test. Physics is less easily studied in private; but as long as a careful examination shows the candidate's knowledge to be sufficient, it is surely a matter of indifference how he came by his information. As to chemistry, all will admit the importance of attending a course of properly illustrated lectures; but a knowledge of lecture-table chemistry will not make a man a chemist, any more than skill in laboratory manipulation alone will suffice for that purpose. Working Fellows of the Institute have a painful knowledge of the awful rubbish frequently turned out by some of the "Colleges," the curriculum of which is accepted by the Council as evidence of adequate training, and it is an open secret that such courses have often to be succeeded by a study of the elements of analytical chemistry in the laboratory of a practising chemist.

By all means make the examinations as rigid and searching as possible, so as to ensure true competency on the part of those candidates who pass. On the other hand, while requiring a sound knowledge of chemistry, &c., generally it would only be fair to allow a candidate the option of being examined more especially in some particular branch, such as chemical engineering, metallurgical chemistry, sanitary chemistry, organic research, &c. But it is ridiculous to depute any one man to act as examiner in chemistry, as, with all respect to those gentlemen who have hitherto acted in that capacity, no one man is likely to have such a thorough knowledge of chemistry as to qualify him to form a judicial opinion on the knowledge of a candidate. The questions hitherto set to students have, I believe, never been published, as they certainly should have been.

The truth is, that the Institute is dominated by the school-master interest. A chemist who exercises the functions of a science-teacher assumes a superiority over those of greater experience and all-round knowledge of the profession who happen to be engaged in private practice, and he is very ready to impress on the public and sucking students his exalted position as Professor Dash as compared with those of Mr. Blank.

Whether devised with such an intention or not, the practical effect of the existing regulation is to boycott Mr. Blank and to swell the fees of Professor Dash.

I am one who has been foolish enough to pay his subscription to the Institute for a number of years, in the hope, long deferred, that some good would come of it at last; and now it promises to boycott me and to admit a number of chemists who, for reasons doubtless satisfactory to themselves, have hitherto stood aloof. I am sorry I did not do the same, and am prepared to resign now if things are not altered.

It is quite clear that, as at present constituted, the Institute will not include many whose knowledge and attainments fully qualify them for membership, and therefore it cannot exercise the functions to which it aspires. Hence, if it cannot be altered to a reasonable working form, it will be better for those who think with me to leave it at once in a body than to pay their subscriptions for nothing for a certain term of years. and then have the affair wound up, or find they have created a Frankenstein. I cannot afford to offend the powers that be, but if I knew I had adequate support I would do my utmost to remedy the present condition of affairs, and have therefore requested the publisher to forward any letters addressed to me at the office of this Journal. Any communications I may receive will be regarded as confidential, and shall be duly acknowledged through the post.—I am, &c.,

A. Blank.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I do not agree with your correspondent "V." that "between 1877—80 the doors of the Institute were opened sufficiently wide and long" to admit all who might justly claim to be enrolled as members, and I think the proposal to admit for a time on "evidence of fitness" is a step in the right direction in the interests of the Institute itself.

The panic created in the minds of certain members by the proposal to suspend examinations for a time is remarkable, when we remember that somewhere about 90 per cent of the present members were enrolled without any examination.

If it was possible in the past to form a satisfactory nucleus without examinations, it is difficult to understand how a renewal of the practice should be so reprehensible now. There are many competent chemists who would willingly join the Institute if permitted to offer evidence of their ability, and who, as busy specialists, could not now without preparation pass the practical examination in general analytical chemistry required by the Institute.

While I do not think that the qualifications required by the Institute are at all too high for candidates who have had an opportunity of preparing themselves, I do think that the requirements are too exacting to suit chemists who have earned their bread by the exercise of their profession before the Institute of Chemistry had any existence; and to these some consideration should be extended.

I would venture to suggest that the degree of Associate should be made a permanent one, instead of being probationary as at present, to those admitted on "evidence of fitness," with permission to take the degree of Fellow on passing the necessary examinations, or on publishing an original research of sufficient merit.—I am, &c.,

A Manure Works' Chemist.

ANALYSIS OF A NORWEGIAN ICEBERG.

To the Editor of the Chemical News.

Sir,—The following analysis is being largely circulated as an advertisement in the West End; but seeing that it contains such interesting scientific matter I am sure you will think it worth recording in your columns, more especially as the analysts have been the first to discover *magnesium* as a natural product, and that, strangely to say, in a *block of ice*; the *alumina*, I presume, is also held in suspension.

"The following is an analysis of a *block of ice* as supplied by us;—

Chloride of potass	..	One grain and a quarter.
Magnesium	..	Half a grain.
Sulphate of lime	..	One quarter of a grain.
Alumina	..	One quarter of a grain.
Organic matter ..	..	None whatever.

Signed —— ——."

Would the above discovery be considered as sufficient "evidence of fitness" by the Council of the Institute of Chemistry for admittance to that august Corporation?—I am, &c.,

Jack of All Trades, Master of None.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Academie des Sciences. Vol. ci., No. 24, December 14, 1885.

Method of Analysis applicable to Mixtures of Hydrocarbons of the Aromatic Series.—C. Friedel and J. M. Crafts.—This memoir will be inserted in full.

Relations between the Absorption of Light and the Emission of Phosphorescence in the Compounds of Uranium.—Henri Becquerel.—The uranium compounds may be divided into two classes corresponding to distinct optical properties. The former are for the most part phosphorescent. On analysing with the spectroscope the light which they emit we perceive in general a discontinuous spectrum formed of seven or eight bands or groups of bands, regularly distributed between the rays C and F, the positions and apppearances of which vary with the nature of the compounds. These same substances present an absorption spectrum formed of bands, the position, grouping, and aspect of which represent in the spectrum the continuation of the regular series of the bands which they emit on phosphorescence. The wave-lengths of all the bands, whether of the phosphorescence spectrum or of the absorption spectrum of one and the same compound, are connected by a law which may be expressed as follows:—the difference of the numbers of luminous vibrations during the same time is sensibly constant in passing from one group to the next, and the value of this difference varies little for the different compounds of uranyl. Each absorption band corresponds to a totality of radiations which excite phosphorescence. On exciting various compounds exclusively by the radiations corresponding to each of the absorption-bands the author finds that in each case the phosphorescence spectrum presents the seven or eight bands less refrangible than the exciting region in question. Thus the radiations absorbed by the uranyl compounds, satisfying a common law, all excite in these bodies the same luminous vibratory movements of different periods, and which appear to be the lower harmonics of the exciting radiations. The uranous compounds, which do not present any appreciable phosphorescence, give a very remarkable discontinuous absorption-spectrum, from F to very far in the ultra-red. Strong absorption bands in the red and ultra-red region are characteristic of the uranous compounds, as well as a broad band in the green ($\lambda = 549$) very near in position to that of the most intense group of lines of the emission spectrum of incandescent uranium. The absorption-bands of the uranous compounds follow with a remarkable regularity the law of distribution of the phosphorescent emission-bands of the uranic compounds, but without having the same relative intensity.

Band-Spectrum of Nitrogen; its Origin.—H. Deslandres.—Of the three groups of bands recognised the author traces the third to an oxide of nitrogen, probably hyponitric acid. The second group is probably due to ammonia, whilst the first may be ascribed either to nitrogen alone or to another compound of nitrogen and hydrogen.

The Hydrates of Arsenic Acid.—A. Joly.—A thermochemical study of the hydrates of arsenic acid, of which the author distinguishes three, containing respectively 2, 3, and 4 mols. of water.

Researches on the Formation of Deposits of Sodium Nitrate.—A. Muntz.—These deposits owe their origin to the nitrogen of organic matters, oxidised under the influence of the ferment of nitrification. Sea-water, or, perhaps, the water of salt-marshes, has been in contact with these substances during the course of nitrification. Sodium nitrate is produced by the double decomposition of the calcium nitrate and of sodium chloride. The nitre has not been formed in the districts which it now occupies, but has been concentrated there after leaving its place of origin.

New Researches on Proteic Substances.—P. Schützenberger.—As the formula of albumen the author adopts $C_{29}H_{48}N_8O_{10}$.

Preparation of Benzoyl-cyanacetic Ether and of Cyan-acetophenone.—M. Haller.—The former body appears as hard, prismatic crystals, soluble in alcohol, ether, potassa, and sodium carbonate. They melt at 37·5°. The alcoholic solutions have a distinctly acid reaction and give with ferric salts a fine red colouration.

Increase of Nitrogen in a Soil kept in Grass.—P. P. Dehérain.—The author thinks, with Lawes and Gilbert, that the nitrates of subsoil waters may rank among the sources of combined nitrogen. In a soil like that of a meadow, never disturbed, the losses by slow combustion are smaller than in an arable soil.

Chemical Study of Matter dredged up by the Travailleur and the Talisman.—M. Dieulefait.—Copper and zinc were both universally detected in deposits obtained at great depths, and in regions of the ocean widely remote from each other.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Algin.—(Reply to E. B.)—If this correspondent will send his name and address samples of algin shall be forwarded to him.—E. C. C. STANFORD, Glenwood, Dalmuir, N. B.

Electrical Battery.—Can any of your correspondents inform me where I may obtain particulars of a form of electrical battery, in which the exciting liquid is a hot supersaturated solution of either nitrate of potash or soda, one of the elements being carbon made red-hot before being plunged into the nitrate; the other I do not know.—G. S. PACKER.

MEETINGS FOR THE WEEK.

MONDAY, 4th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Chemical Industry, 8. "Enrichment of Coal-gas by Hydrocarbons," by Mr. G. E. Davis. "Notes on Russian Turpentine," by Mr. C. T. Kingzett.
TUESDAY, 5th.—Royal Institution, 3. "The Story of a Meteorite," by Prof. Dewar.
—— Pathological, 8.30. (Anniversary).
THURSDAY, 7th.—Royal Institution, 3. "The Story of a Meteorite," by Prof. Dewar.
—— London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 8th.—Quekett Club, 8.
—— Astronomical, 8.
SATURDAY, 9th.—Royal Institution, 3, "The Story of a Meteorite," by Prof. Dewar.

TO CORRESPONDENTS.

Oxonian.—The attack is too personal to be inserted.

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In the matter of Letters Patent granted to JOHN FORDRED, of Tottenham, in the county of Middlesex, for "Improvements in the preparation of grain or cereals for use in brewing, distilling, and vinegar making," dated 8th November, 1881, No. 4891.

NOTICE IS HEREBY GIVEN that the said John Fordred has applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were published in the Official Journal of the Patent Office, issued on the 18th December, 1885.

Any person intending to oppose the said application must leave particulars in writing of his objections thereto at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C., within one calendar month from the date hereof.

Dated this 18th day of December, 1885.

(Signed) H. READER LACK,
Comptroller General.

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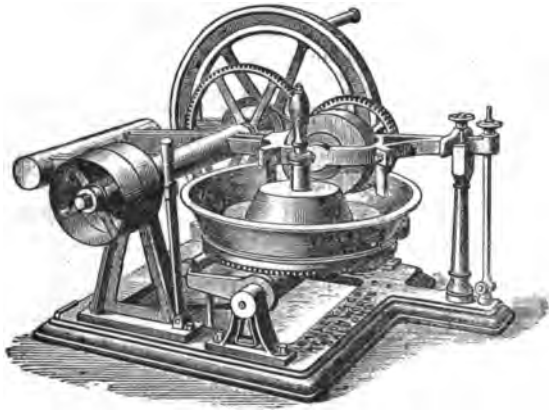

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THE CHEMICAL NEWS.

VOL. LIII. No. 1363.

ON THE LIMITED HYDRATION OF AMMONIUM CARBAMATE.*

By H. J. H. BENTON, M.A., F.C.S., F.I.C.,
Demonstrator of Chemistry in the University of Cambridge.

IT occurred to me that a study of the action of water on ammonium carbamate, with reference to the influence of time, mass, and temperature, would be of interest as tending to throw light upon the laws which govern a chemical action of the simplest type in the liquid state—the action consisting of the direct union of two simpler molecules to form one more complex—

$$CO(NH_2)(ONH_4)+OH_2=CO(ONH_4)_2.$$

There are but few such actions which can be investigated, where all the substances are in the liquid state and all extraneous matter absent.

In a paper read before the Chemical Society in 1879,† I showed that ammonium carbamate when acted upon by sodium hypochlorite in presence of sodium hydroxide, yields one-half of its nitrogen in the free state, the other half remaining in the form of sodium carbamate—

$$2CO(NH_2)(ONH_4)+3NaClO+2NaOH=$$
$$=2CO(NH_2)(ONa)+3NaCl+5OH_2+N_2.$$

Sodium hypobromite at once decomposes sodium carbamate, evolving its nitrogen in the free state—

$$2CO(NH_2)(ONa)+3NaBrO+2NaOH=$$
$$=2CO(ONa)_2+3NaBr+3H_2O+N_2.$$

This, in fact, may be claimed as a specific reaction for carbamates—no other substance yet investigated will yield nitrogen when treated with a hypobromite *after* the completed action of a hypochlorite. Urea evolves but half its nitrogen with a hypochlorite, in presence of caustic alkali, but the other half remains as a cyanate, which is not acted upon by a hypobromite.‡

Based upon this reaction, then, we have a direct and simple method of determining the amount of carbamate existing in a solution at any given time.

Since, under the action of a hypochlorite, ammonium carbamate yields one-half of its nitrogen (*i.e.*, that present as ammonium), it is evident that any excess over and above this half which is evolved from its solution, is a measure of the water which has been assimilated, converting the carbamate into carbonate.

For the sake of convenience we may express the hydration which occurs in terms of the ratio of the number of molecules of water assimilated to that of the molecules of ammonium carbamate taken. Let V = the total volume of nitrogen contained in the ammonium carbamate taken, and V_1 = that evolved by the action of a hypochlorite on its solution. Then the above ratio evidently = $\frac{2V_1-V}{V}$ (since one atom of nitrogen evolved in excess of the half total corresponds to one molecule of water assimilated, and two atoms of nitrogen originally present represent one molecule of ammonium carbamate taken).

The ammonium carbamate used in these experiments was prepared by the direct union of carefully dried ammonia and carbon dioxide. The apparatus employed in the estimation of the evolved nitrogen was similar to that described in a former paper on the action of "Hypochlorites in Urea."‡

* A Paper read before the Royal Society, December 10, 1885.
† *Chem. Soc. Journ.*, 35, 12.
‡ *Ibid.*, July, 1878.

Experiments were undertaken with a view of investigating to what extent the action is influenced by (1) time, (2) mass, (3) temperature and (4) to study the reverse action, namely, the dehydration of normal ammonium carbonate into ammonium carbamate.

I. *Influence of Time.*

Weighed quantities of ammonium carbamate were dissolved in water and the solutions made up to a definite volume. Measured portions were then withdrawn and examined at stated intervals by treatment with sodium hypochlorite and sodium hydroxide; care being taken to employ approximately the same quantities of reagents for each experiment of the series. The times were reckoned from the moments of complete solution of the salt.

6·2873 grms. ammonium carbamate dissolved in water—the solution made up to 100 c.c. and 5 c.c. (corresponding to 0·31437 grm. of carbamate) taken for each experiment. Theory for total nitrogen = 90·20 c.c.

Minutes.	Intervals.	C.c. of Nitrogen (corrected).	Hydration.
5	1	54·16	0·2008
10	2	56·71	0·2575
20	4	60·37	0·3386
40	8	66·04	0·4644
60	12	68·60	0·5211
100	20	71·44	0·5842
120	24	72·08	0·5983
160	32	72·72	0·6125

After a further interval of about twenty-four hours, 72·28 c.c. of nitrogen were evolved. Similar experiments were made with a weaker solution, namely, one containing 4·8781 grms. of ammonium carbamate in 250 c.c.; 10 c.c. were taken for each determination, corresponding to 0·1951 grm. of carbamate, and to a total of 55·98 c.c. of nitrogen.

Minutes.	Intervals.	C.c. of Nitrogen (corrected).	Hydration.
5	1	35·09	0·2536
10	2	38·72	0·3833
20	4	40·91	0·4615
40	8	43·20	0·5434
60	12	45·70	0·6327
120	24	47·47	0·6960
220	44	47·57	0·6995

After about twenty-four hours 47·96 c.c. of nitrogen were obtained.

It is evident from these results that the action, which proceeds rapidly at first, becomes progressively slower, and finally reaches a limit short of complete hydration.

The time required to reach a determinate state of hydration is evidently greater for a strong solution than a weak one, *i.e.*, decreases as the relative number of water molecules increases.

II. *Influence of Mass.*

8·3272 grms. of ammonium carbamate were dissolved in water and the solution made up to 100 c.c. (Solution A.)

25 c.c. of solution A were made up to 50 c.c. (Solution B.)

25 c.c. of solution A were made up to 250 c.c. (Solution C.)

The relative strengths were therefore A : B : C :: 1 : ½ : $\frac{1}{10}$.

The solutions were set aside for four days in carefully stoppered flasks and under similar conditions. Volumes of each solution which corresponded to equal masses of ammonium carbamate were then withdrawn—namely, 5 c.c. of A, 10 c.c. of B, and 50 c.c. of C, representing 0·41636 grm. of carbamate—and examined by the hypochlorite method in the usual way.

5	c.c. of	A	gave	95·73 c.c. N (corr.).
10	,,	B	,,	99·99 ,,
50	,,	C	,,	110·60 ,,

In order to be certain that the equilibrium state had been arrived at, the same solutions were again examined after a further interval of two days, when

5 c.c. of A gave 95·35 c.c. N (corr.).
10 „ B „ 99·96 „
50 „ C „ 110·83 „

showing that the limits had been reached in the former experiments. These numbers correspond to the hydrations—

A .. .. 0·5963
B .. .. 0·6735
C .. .. 0·8550

In order further to confirm these results, the residues from the last experiments, after the completed action of the hypochlorite, were treated with sodium hypobromite in order to estimate the nitrogen remaining as carbamate.

Residue from A gave 22·02 c.c. N (corr.).
„ „ B „ 17·50 „
„ „ C „ 8·01 „

making the totals—

A .. .. 117·37 c.c. N (corr.).
B .. .. 117·46 „
C .. .. 118·84 „

theory for 0·41636 grm. ammonium carbamate requiring 119·46 c.c. There is always a loss of about 8 per cent of nitrogen in estimations with hypobromite* : if this correction be applied the agreement will be still closer.

In order to facilitate the interpretation of the results, further experiments were made in the same direction, using mixtures of carbamate and water in simple ratios of their molecular weights.

	Grm. am. carb.		Grms. water.		Mols. of carbamate.		Mols. of water.
(*a*)	0·3270	with	15·09	corresponding to	1	:	200
(*b*)	0·1836	„	12·71	„	1	:	300
(*c*)	0·1307	„	12·06	„	1	:	400
(*d*)	0·1042	„	12·02	„	1	:	500

After standing for some days under similar conditions the following results were obtained :—

	C.c. of N (corr.) obtained.	Theory for total nitrogen.	Hydration.
(*a*)	82·02	93·80	0·7487
(*b*)	47·29	52·66	0·7962
(*c*)	34·57	37·49	0·8447
(*d*)	28·62	29·89	0·9156

Another experiment was made in which the ratio of the molecular weights was nearly 1 : 1, namely, 0·2614 grm. ammoni m carbamate with 0·0632 grm. water. After standing for two days, 49·52 c.c. nitrogen (corr.) were obtained—theory for total nitrogen requiring 75·0 c.c. The hydration was therefore 0·3187.

It follows from the above results that the hydration is a function of the number of water molecules present. So far the minimum hydration corresponds to the case in which the substances are present in about equal molecular proportions, and is in this respect analogous to the combination of iodine with hydrogen† and of phosphorus trichloride with chlorine.‡ From analogy it was to be expected that the hydration would again increase as the ratio of the ammonium carbamate molecules to those of water increased; but the experiment cannot be made under the same conditions as those above, since with any appreciable excess of the carbamate the water is insufficient to completely moisten the solid.

* Russel and West, *Chem. Soc Jour.*, 27, 749

† Lemoine, "Equilibres Chimiques entre l'Hydrogène et l'Iod Gazeaux," *Ann. Chem. Phys.*, [5], xii., 145.

‡ Wurtz, *Comptes Rendus*, lxxvi., 602.

III. *Influence of Temperature.*

The above results may be taken as representing the phenomena which occur at about 20 to 22° C., from which the temperature varied but little throughout the experiments.

In order to gain some idea as to the effect which temperature might have upon the action, two equal volumes of an arbitrary solution of ammonium carbamate were taken and kept in sealed vessels, one at the temperature of the room—about 15° C., and the other in melting ice. After about five hours the solutions were examined by the hypochlorite method, taking care to keep the apparatus in each case as nearly as possible at the respective temperatures.

Solution at 0° C. gave 68·0 c.c. N (corr.).
„ 15 „ 79·4 „

Similar pairs of experiments were made with another solution at stated intervals, equal volumes being measured out in the first instance and then subjected to the respective temperatures in sealed vessels.

Solution at 0°.

After 30 minutes gave 63·7 c.c., solution at 15° gave 76·2
„ 1 hour „ 73·0 „ „ 83·2
„ 2 hours „ 74·0 „ „ 88·9
„ 4 „ „ 76·3 „ „ 90·6

The hydration is therefore, in all cases, less at the lower temperature.

The minimum hydration will probably occur at a sufficiently low temperature, and when the substances are present in equal molecular proportions. A mixture was made of 0·6199 grm. ammonium carbamate with 0·1424 grm. of water—corresponding almost exactly to equal molecular weights. This mixture was kept in a sealed tube placed in a block of ice for eighteen hours, when it may be safely assumed that the equilibrium state was arrived at. It was then examined by the hypochlorite method (the apparatus being kept at about 0° C. throughout), and yielded 95·90 c.c. of nitrogen (corrected). Theory for total nitrogen requires 177·1 c.c., so that the hydration is represented by 0·0830.

Probably, at a sufficiently low temperature the hydration would be practically *nil*, when the substances are present in molecular proportions—*i.e.*, ammonium carbamate and water would practically *not combine at all*—resembling the cases of phosphorus trichloride and chloride, &c., at sufficiently *high* temperatures.

IV. *Dehydration of Normal Ammonium Carbonate.*

The salt was prepared by the method of Divers.* About 5 to 6 grms. of it were dissolved in water, and the solution made up to 100 c.c. (A). Portions of this solution were diluted to ½ (B) and 1/10 (C). After two days—

5 c.c. of A gave 35·54 c.c. N (corr.)
10 „ B „ 38·10 „
50 „ C „ 40·85 „

Equal volumes of another solution were examined at intervals, with the following results :—

After 5 minutes 67·94 c.c. N (corr.) were evolved.
„ 40 „ 66·73 „ „
„ about 3 hours 62·52 „ „
„ „ 24 „ 62·28 „ „

These results indicate that normal ammonium carbonate undergoes dehydration into carbamate when in solution, and that the dehydration is greater as the relative number of water molecules is less.

The instability of normal ammonium carbonate, and the difficulty of obtaining it free from adhering impurities, has, for the present, prevented me from making more extended observations on this part of the subject. It

* *Chem. Soc. Jour.*, 23, 179.

seems not unlikely, that if the same relative number of molecules could be started with, the same equilibrium state between carbamate, carbonate, and water, would be arrived at for the same temperature, whether ammonium carbamate or normal carbonate were initially taken—that is, that the curves of hydration and dehydration would meet at the same point. I hope before long to be able to make experiments in this direction.

Since there is this tendency for ammonium carbonate to become in part dehydrated in aqueous solution, and for the system to come to a state of equilibrium where the carbamate and carbonate co-exist, it seems probable that the hydrolysis of urea, under the action of ferments, &c., may be less simple than is usually represented—that the reaction, instead of being simply—

$$CO(NH_2)_2+2H_2O=CO(ONH_4)_2,$$

may be of the following type :—

$$nCO(NH_2)_2+(2n-m)H_2O=mCO(NH_2)(ONH_4)+(n-m)CO(ONH_4)_2.$$

I propose to attack this subject by the same method as those employed above.

By means of the actions of sodium hypochlorite and hypobromite it is evidently possible and easy to estimate quantitatively *urea*, *carbamic acid*, and *ammonia*, when all are present in the same solution.

Take two equal portions of the solution to be examined, treat one with sodium hypobromite, and let the volume of nitrogen evolved (corrected for loss) $=V_1$.

Treat the other portion with sodium hypochlorite, and let V_2 = volume of nitrogen obtained.

Act upon the residue from this last experiment with sodium hypobromite, and let V_3 represent the volume of nitrogen given off (corrected).

Let x = volume of nitrogen due to urea.
" y = " " ammonia.
" z = " " carbamic acid.

Then—

(1.) $x+y+z=V_1$.

(2.) $\frac{x}{2}+y=V_2$.

(3.) $z=V_3$.

A preliminary trial of this method with a mixture of urea and ammonium carbamate gave very satisfactory results.

It appears to me that no really satisfactory method has hitherto been known by which carbamic acid could be detected and estimated in presence of urea and ammonia, so that the process indicated above may perhaps be of service in investigations bearing on the formation of urea in the animal body, and its origin, whether carbamic or otherwise.

THE DETERMINATION OF GLYCERIN.

By WILLIAM FOX and J. A. WANKLYN.

During an investigation on the constitution of oils and fats, with which we are engaged, it became necessary to make a number of glycerin determinations, and as experiment proved the ordinary methods to be inaccurate, we worked out the method given below, and which is based on the fact that glycerin, oxidised with permanganate of potash in a strongly alkaline solution, gives oxalic acid according to the equation

$$C_3H_8O_3+O_6=C_2H_2O_4+CO_2+3H_2O.$$

The oxalate can be precipitated by a lime salt, and the amount of oxalic acid determined, and the equivalent quantity of glycerin calculated therefrom.

We carry the process out as follows :—

The aqueous solution of glycerin (which should not contain more than 0·25 grm. $C_3H_8O_3$) is made strongly alkaline by adding 5·0 grms. of solid caustic potash; powdered permanganate of potash is then gradually added until the solution is of a permanent pink colour; the solution is now kept at boiling point for half-an-hour, and then the excess of $K_2Mn_2O_8$ decomposed with sulphurous acid, either in solution or the gas may be used. The solution, which should now be colourless, is filtered from the precipitated oxide of manganese, and made acid with acetic acid and boiled; a lime salt is added, and the resulting oxalate collected on a filter and thoroughly washed with boiling water. As the precipitate is not pure oxalate of lime, we determine the oxalic acid in the lime salt by titrating with standard $K_2Mn_2O_8$ in the usual way; with a moderate amount of care this process is very accurate; the difference in several experiments should be under a half per cent, and Messrs. Benedikt and Zsigmondy, since we suggested the process, have obtained very satisfactory results, which they publish in the *Moniteur Scientifique Quesneville*, vol. xv., October, 1885.

In the saponification of fats in which it is proposed to estimate the glycerin, care should be taken to have the whole of the alcohol driven off, as dilute alcohol treated with alkaline permanganate gives oxalic acid. It may be mentioned that the acids of the acetic series do not oxidise to oxalic acid with alkaline permanganate, whilst those acids of the acrylic series do.

Laboratory, 4, Great Tower St., E.C.,
December 29, 1885.

COLOURED REACTIONS OF PHENOLS WITH CARBOHYDRATES.

By ANTON IHL.

These reactions are produced by adding the pulverised carbohydrates to an alcoholic solution of the phenol.

α-Naphthol gives with cane-sugar at a gentle heat a splendid reddish violet colour, which disappears on the addition of water; with milk-sugar a fine violet and with starch a dark red violet.

β-Naphthol gives with cane-sugar a yellow, which on prolonged boiling turns a dark greenish yellow with a greenish fluorescence; with milk-sugar, a pure yellow without fluorescence; with glucose, a yellowish green colour with a strong green fluorescence; with dextrin, a yellowish; with arabin, a light yellow; and with starch, a faint yellow.

Resorcin gives with cane-sugar an intense fiery red, which retains its colour on dilution with water; with milk-sugar, glucose, dextrin, arabin, and starch, yellowish red.

Pyrogallic acid gives reactions very similar to those of resorcin.

Phloroglucine gives with cane-sugar, on gently heating, an intense yellowish red colour, which became a fine light yellow on dilution with water; with milk-sugar a reddish brown; with glucose, a yellowish red; with dextrin, a slight dirty yellow; with arabin, on prolonged heating, an intense cochineal-red pigment, which is permanent on the addition of water.

The phenols are also well adapted for the detection of woody matters. They are used in an alcoholic solution, mixed with hydrochloric or sulphuric acid, and applied either cold or hot to the paper or wood in question.

Solution of orcin mixed with hydrochloric acid gives a splendid dark-red on wood; upon paper containing wood-stuff it gives a dark red-violet spot. Pure cellulose-paper undergoes no change.

Resorcin with alcohol and hydrochloric acid colours wood-stuff paper a violet-blue in a short time. Pure cellulose-paper remains unaffected. Resorcin with alcohol and sulphuric acid (one vol. alcohol, one-third vol. sulphuric acid), when warm, colours wood-paper or wood a dark violet-blue. Pure cellulose-paper is coloured an onion-red.

α-Naphthol in alcohol and hydrochloric acid colours wood-stuff paper and wood greenish.

α-Naphthol, in equal volumes of alcohol and sulphuric acid, colours wood-stuff paper a dark green, whilst pure cellulose-paper takes a red-violet.

Pyrogallic acid in alcohol and hydrochloric acid colours wood-stuff paper and wood a bluish green.

Carbolic acid in alcohol and muriatic acid colours wood and paper containing wood a yellowish green.—*Zeit. f. Anal. Chemie* from *Chemiker Zeitung*.

A THEORY OF THE CONNECTION BETWEEN THE CRYSTAL FORM AND THE ATOM COMPOSITION OF CHEMICAL COMPOUNDS.*

By WILLIAM BARLOW.

(Concluded from page 6.)

I WILL now deal with a more complex case, that of compounds composed of three kinds of atoms present in the proportions 1 : 2 : 3.

Since, when infinite numbers of three sorts of small bodies present in these proportions are taken, half of the bodies are of one kind, it is evident that a symmetrical disposition of these, the most numerous kind, will be made if they have the arrangement of one of the sets of bodies in one of these two systems for two kinds of bodies in equal numbers (Figs. 3 and 4). Consequently we shall

FIG. 3.

FIG. 4.

have a symmetrical system for the three kinds if we can arrange the two less numerous kinds in a symmetrical manner, so that together they shall fill the places of one set of bodies in one of these two systems.

Now the centres of the balls *of one colour* in this stack (Fig. 3) have a similar arrangement to that of the centres of *all the balls* in this one (Fig. 4), and the centres of the balls of *one colour* in this one (Fig. 4) have a similar arrangement to that of the centres of all the balls in either of these three stacks (Figs. 6, 7 and 10). And if we remove a corner from this stack (Fig. 4) we see that this system, like the systems of these other stacks (Figs. 6 to 11) may be regarded as made up of plane systems of points arranged triangularly (see Fig. 12). Thus, then, in both these stacks (Figs. 3 and 4) balls of two colours

FIG. 6.

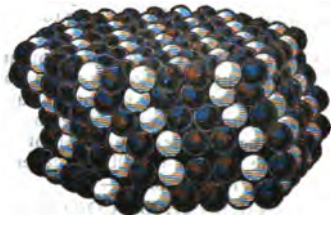


FIG. 7.

present in the proportions 1 : 2 can be arranged with perfect symmetry to fill the positions at present occupied by balls of one colour.

FIG. 8.

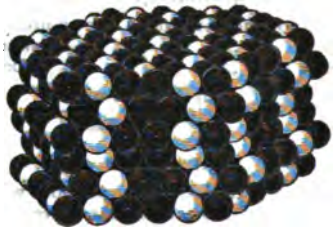
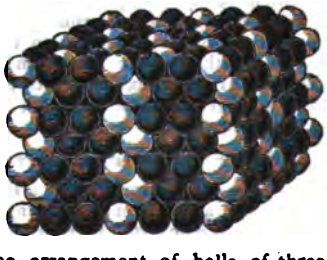


FIG. 9.

FIG. 10.



When the arrangement of balls of three colours in these various ways is accomplished, we have obtained six distinct typical symmetrical systems of arrangement of three kinds of small bodies present in the proportions

* A Paper read before Section B, British Association, Aberdeen Meeting.

1 : 2 : 3, three according to each of the two systems (Figs. 3 and 4).

Again, three other typical systems for atom combinations of this kind are obtained if we place at the centres

FIG. 11.

of the spaces between the bodies in the three infinite systems of two kinds of small bodies present in the proportions 1 : 2, depicted by these three stacks (Figs. 6, 7, and 10), a third kind of small body, the systems thus obtained

FIG. 12.

—like the three systems from which they are derived—will evidently two of them be uniaxal, the third trimetric. The latter, derived from this form (Fig. 10), is here depicted (Fig. 13).

FIG. 13.

As in all the nine systems I have thus indicated, the arrangement of the different colours will evidently not be symmetrical about three axes at right angles to one another, as it is in these two systems (Figs. 3 and 4), we must, as in the other cases of symmetry already referred to which are not of the cubic system, employ spheroids or ellipsoids in place of spheres, if we wish to depict the precise symmetrical form proper to any particular case.

In six out of the nine the symmetry is uniaxal, and therefore similar spheroids would be used. In the remaining three cases the symmetry is trimetric, and suitable similar ellipsoids would have to be employed. As before, the form of spheroid or ellipsoid to be used would depend on the kinds of atoms associated in the compound.

I remarked just now that if calcium has but half the atomic weight usually attributed to it, the composition of Iceland spar would be in harmony with its crystal form. I will now proceed to show this.

In this case Iceland spar would be an example of the kind of compound which we have just been considering, for it would contain 1 atom of carbon, 2 atoms of calcium, and 3 of oxygen. (What follows would apply equally well if it contained 1 atom of calcium, 2 atoms of carbon, and 3 of oxygen.)

Now four of the six systems for compounds of this kind which I just now derived from these two cubic systems (Figs. 3 and 4) are symmetrical about a single axis which has the direction of one of the diagonals of the cube outlined by the stack; and when we employ appropriate symmetrically placed spheroids instead of spheres, we shall therefore, in either of these four systems, have a rhombohedral form in place of the cubic. This is in harmony with the fact that Iceland spar crystallises in rhombohedra.

It is interesting to notice that in two of the four systems which I have just referred to, those two which are derived from this system (Fig. 3), we have one kind of small body—that which represents the oxygen atoms—ranged in planes having directions exactly corresponding to the directions of cleavage of crystals of Iceland or calc spar.

The dimorphic form of the same compound, known as aragonite, would be referred to one of the three *trimetric* systems of symmetry which I have just traced.

It is evident that, if we pursue the methods I have thus indicated, a very great variety of symmetrical arrangements of different kinds of small bodies present in various different given proportions may be derived from the few symmetrical systems of arrangement of points in space of which the models before you are examples. Thus, as another example, we have here a symmetrically arranged plane system of balls of two colours present in the proportions 1 : 3 (Fig. 14). And when these are built up to

FIG. 14.

show the arrangement for compounds of two kinds of atoms present in these proportions, the system produced will be found in harmony with the crystal form of several of such compounds. The very simple symmetrical systems of arrangement of points in space I have selected as typical systems, from which to derive symmetrical arrangements for different atom proportions, are five in number (Fig. 3 gives one system; Fig. 4 gives a second; Figs. 6, 7, or 10, a third; Figs. 8, 9, or 11, a fourth; and Fig. 13 a fifth).

The reason for my selection of these particular systems is that they exhibit far greater evenness of distribution of the points than is found in any other symmetrical system of points in space. For four of them are distinguished from all other symmetrical systems by the property that if the nearest points grouped around any point of a system are joined, the solid thus outlined has its edges all equal; and the fifth (Fig. 13) is distinguished by the property that, in the case of some of the points, when the nearest points grouped around any one of them are joined, the solid outlined has equal edges, and in the case of the re-

maining points, when the next nearest points are joined, this is the case.

I would suggest that these five systems probably furnish all the types from which all the systems according to which the atoms of crystallising compounds are arranged can be derived, the relative distances between the atoms, and consequently the relative dimensions of the actual systems in different directions, depending, however, on the kinds of atoms present, and their relative numerical proportions.

In referring all systems to these few types, there is, however, one observation that I ought to make. The symmetry of a system of different kinds of small bodies will evidently not be impaired by the removal of all the similarly situated bodies of a given kind. For instance, the symmetry, as to the arrangement of colour, of this system (Fig. 13) would be equally great if all the least numerous kind of balls were removed, the balls of the other two kinds remaining in the same positions. Now I suppose that where the relative numbers of different atoms present is not such as to allow of their arrangement to fill all the places in a symmetrical system such as is here depicted, a set or sets of symmetrically situated places in the system may be left unoccupied.

Thus the atoms of a compound of two kinds of atoms present in the proportions 2 : 3 might, I suggest, be arranged according to this system (Fig. 13), the places marked by the centres of the least numerous balls being left vacant.

The disposition in space in such cases would not be so even as when all the positions are occupied, but would be improved if the atoms slightly closed in upon the vacant spots in a symmetrical manner.

Several compounds of two kinds of atoms in the proportions 2 : 3 crystallise in six-sided prisms or in rhombohedral forms (*e.g.*, Al_2O_3 in six-sided prisms; Fe_2O_3,Cr_2O_3 in rhombohedral prisms.

Where many different kinds of atoms are present it is probable that the symmetry of disposition reached is not perfect with respect to all the different varieties of atoms, but that atoms of allied kinds to some extent occupy similar positions almost indiscriminately; perhaps for the purpose of symmetrical disposition, the atoms fall into three or four classes.

This view is countenanced by some o the facts of isomorphism.

Before closing I may call attention to a few other facts concerning crystals as supporting my theory.

Thus there are close resemblances between the different types. For example, four of our five arrangements of points in space may be regarded as made up of similar plane systems of points triangularly arranged. The result of this similarity evidently is that the atoms of a given compound have to make but a slight change of their relative positions in order to pass from one system of possible arrangement to another, and this fact seems to throw light on the readiness with which dimorphic changes occur in some cases.

As an instance of this readiness I may refer to the familiar fact that mere contact with foreign bodies sometimes causes rhombohedral crystals of saltpetre to become turbid, and effects their transformation to crystals of a prismatic form.

Again, the occurrence of dimorphism is in harmony with that variety in the types of symmetrical arrangement of the same atom-combination which I have shown to be possible, and this variety of types further accounts for the variety of forms presented by different compounds whose atom proportions are similar.

The cause of dimorphism we may suppose to be that in some cases slight changes in the relative degrees of attraction and repulsion, exercised by the different atoms of a compound on one another, cause stable equilibrium of their various forces to be found in a different system of symmetry.

The fewness of our types is consistent with the fact of very diverse compounds crystallising according to the same system.

I suppose that the faces of crystals have the direction of planes which contain a large number of the symmetrically situated points. Thus the faces of cubes indicated by their stacks (Figs. 3 and 4) have the directions of planes containing the centres of all the outlying balls, and the faces of octahedra indicated by this one (Fig. 15)—in

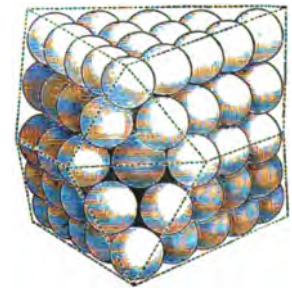
Fig. 15.

which the centres are as in these three (Figs. 8, 9, and 11)—have the directions of planes containing the centres of the outermost balls.

That this relation between the directions of crystal faces and the supposed symmetrical arrangement of the atoms in space subsists is entirely supported by the law of the rationality of the parameters; for if we examine stacks of sufficient magnitude, we find that the series of plane directions actually exhibited by crystals of the same substance are those, and those only, which will fulfil this condition, that they intersect a large number of the symmetrically placed points.

In cases of hemihedral and tetrahedral forms we may suppose that the directions of the faces omitted and the directions of the corresponding faces existing intersect different sets of atoms. For example, in these two hexagonal forms of arrangement of two kinds of atoms (Figs. 8 and 9) pyramid planes drawn to three alternate prism faces do not in any case intersect similar plane systems of atoms to those intersected by pyramid planes drawn to the remaining three prism faces.

Fig. 16.



The difference of bulk produced in any crystal by a change of temperature we shall naturally attribute to changes in the values of the forces of attraction and repulsion exercised by the different atoms on one another; and in harmony with this we shall refer the fact of crystals not of the cubic system expanding in different degrees in different directions according to their symmetry, to the attractions and repulsions exercised by the different kinds of atoms changing differently when a change of temperature takes place.

The phenomenon of the formation of twin crystals is in

harmony with my supposition that the atoms in crystals are very evenly distributed in space; for it will be found that the modification of the distribution of the atoms indicated by this phenomenon is not such as perceptibly to impair the evenness of distribution.

To illustrate this. In this arrangement of balls showing an octahedral form (Fig. 15) the balls are arranged according to the third of our five typical arrangements of points in space. When I remove the balls down to the middle layer I get a hexagonal plan, and I have only to shift the upper balls round bodily through 60°, and place them in a precisely similar way upon the lower balls, and we get the twin form (Fig. 16).

My supposition that the arrangement of the atoms of a crystallising body symmetrically takes place gradually is countenanced by the fact that the longer the process of crystallisation is about the larger the crystals produced. For the natural explanation of this, according to my theory, is that the longer any mass, whose atom composition is such as to allow of the formation of crystals, continues in a state of transition from a liquid to a solid condition, the greater the opportunity for the passing waves of condensation and rarefaction to perfect the symmetrical distribution of the different kinds of atoms, *and to make it continuous over larger spaces.*

With reference to the crystallisation of the elements, it is clear that the effect of waves of alternate condensation and rarefaction, where one kind of atom only is present, will be to produce the simplest, most compact, kind of arrangement possible,—that in which each atom is equidistant from twelve surrounding atoms (Fig. 15).

The greater number of the elements crystallise in octahedra, which harmonises with this view.

Where they crystallise according to other systems than the regular system, my theory appears to oblige us to conclude that, under the conditions prevalent at the time of crystallisation, they contained different kinds of atoms, or atoms having different definite states.

In closing, just a word or two as to isomorphism.

Apart from the distribution of colour, three of our five fundamental systems are symmetrical about three axes at right angles to one another (Figs. 3, 4, and 15), and it is evident that a number of atom combinations will be capable of a perfectly symmetrical arrangement with respect to these three axes, according to one or other of these three systems. All compounds whose different atoms can be thus symmetrically arranged with respect to three axes we shall expect to crystallise according to the cubic system, and thus to be isomorphous with one another.

As to other cases of isomorphism, it supports my theory that, as a rule, the isomorphous bodies contain similar proportions of some of the same elements, *e.g.*, calc spar and spathic iron ore.

It is natural to suppose that here the symmetrical systems are similar in the different compounds, and that the atoms common to both have identical dispositions. But it will be asked, How is it that the attractions and repulsions exercised by the atoms which are not common to the different isomorphous compounds do not cause the departures from the root or type form to be very perceptibly different in different compounds? I remark, in reply, that where great symmetry prevails in a system of several kinds of atoms, a considerable variation in the attractions and repulsions exercised by *one* kind on the rest would not necessarily alter the form of the system materially. In other words, the fact of the attractions and repulsions exercised by one set of atoms being different from those exercised by the corresponding set of atoms in a compound isomorphous to it may not produce a perceptible difference of form of the symmetrical systems according to which the atoms are respectively arranged.

In cases where the atom composition of isomorphous bodies is very different, I suggest that the atoms common to both may nevertheless have the same disposition.

Take the case of ammonic sulphate, $(NH_2)_2H_2SO_4$, being isomorphous with potassic sulphate, K_2SO_4.

In this case I suppose that the symmetrical arrangement in the former compound is such that the groups $(NH_3)_2$ occupy places which might, without altering the disposition of the remaining atoms be filled by additional groups H_2SO_4; that, in other words, the relative position of the groups H_2SO_4 is precisely the same as it would be if the entire mass consisted of these groups.*

METHODS OF BUTTER ANALYSIS.†

By H. B. CORNWALL.

Three of the commoner methods for examining butter fats by more or less thorough quantitative determination of the fatty acids obtainable by decomposition of the fat, or by allied operations, have been tried by the writer: Hehner's (as well as a modification of it described by Blyth—"Foods, their Composition and Analysis," London, 1882), Reichert's, and Koettstorfer's.

Hehner's process (*Zeitschrift f. Analytische Chemie*, 1877, p. 145) is discussed. His statement that the insoluble acids from 3 grms. of fat will ordinarily require three-quarters of a litre of boiling water is probably true, but Fleischmann and Vieth (*Fresenius' Zeitschrift*, 1878, p. 287), and A. Hanssen ("Inaugural Dissertation," Erlangen, 1882) are quoted to show that 2 to 3 litres of water may be required, and that certain precautions may be necessary in washing.

Hehner's highest limit of 88 per cent of insoluble fatty acids in butter can only be accepted as applying to the great majority of cases. Several writers state that this limit may be too low. Fleischmann and Vieth (*loc. cit.*) set the limit at 90, having found a butter yielding 89·73 per cent. They also quote the *Journal of the Royal Agricultural Society*, 1877, to the effect that Bell found the limits to vary between 85·5 and 89·8. Kretzschmar (*Berlin Berichte*, 10, 2091,) found several butters yielding over 89 per cent, and thinks the highest limit should be 90. (Kuleschoff (Wagner's *Jahresbericht*, 1878, p. 999,) obtained 89·72 per cent. Jehn (*Archiv der Pharmacie*, ix., 1878, 335) found 89 or more per cent. in three out of ten butters, and although he used wax to collect the insoluble acids, yet his results do not show that this deviation was the certain cause of his high figures.

De la Source (Wagner's *Jahresbericht*, 1882, 929) found 89·1 and 89·4 per cent, and objects to the French standard of 88 per cent as too low.

On the other hand, R. W. Moore (Chemical News, December 5th, 1884) found cocoa-nut oil to yield only 86·43 per cent of insoluble fatty acids by Hehner's method, and the writer's experiments tend to confirm his statement. The writer found that the soluble fatty acids could only be very slowly removed from the insoluble fatty acids in the analysis of cocoa-nut oil, even with boiling hot water.

The writer also tried the modification of Hehner's method described by Blyth (*op. cit.*) on cocoa-nut oil, and even with purposely imperfect washing of the insoluble acids (1050 c.c. of wash water in all), found 89·7 per cent of insoluble acids and 3·44 per cent of soluble. The low total, 93·14 per cent, may be due to the persistent loss of weight of the impure insoluble acids in drying on the water-bath. A constant weight could not be obtained. As it was, the cocoa-nut oil would have passed for three-fourths pure butter. It had, as purified by the writer, a bland taste, and was almost absolutely odourless. Moreover, Jeserich and Meinert (Wagner's *Jahresbericht*, 1882,

* The Author has offered an explanation of the nature of chemical combination in his "New Theories of Matter and of Force," published by Sampson, Low, and Co., London.

† Abstract prepared by the Author from the Report of the State Board of Health of New Jersey, U.S.A., for 1884.

932) have patented a process by which they claim that an odourless fat is obtainable from cocoa-nut oil, palm-nut oil, &c., edible and suitable for making artificial butter.

In any event, Hehner's process, pure and simple, must be held incapable of distinguishing cocoa-nut oil in mixtures, if not alone, from true butter fat.

Koettstorfer's method (*Fresenius' Zeitschrift*, 1879, 199), depending on the larger amount of alkali required to saponify butter fat in comparison with a very large number of other animal and vegetable fats, has been shown by Moore (*loc. cit.*) to be unreliable when applied to mixtures containing cocoa-nut oil. Moore mixed cocoa-nut oil and oleomargarine, in proportions previously calculated by himself, and the mixtures, free from butter, gave figures falling between the lowest and highest limits fixed for genuine butter by Koettstorfer.

Reichert (Fresenius' *Zeitschrift*, 1879, 68), devised a method, based on the facts reported by Hehner, and his method consists in determining the acidity of the distillate of soluble fatty acids and water, obtained under constant conditions. The melted fat is filtered, 2·5 grms. of it weighed in a flask of about 150 c.c. capacity, 1 grm. of solid caustic potash and 20 c.c. of 80 per cent alcohol are added, and the whole heated to gentle ebullition on a water-bath with frequent agitation. The alcohol is evaporated on the water-bath, and the heating thus continued until the resulting soap is absolutely free from alcohol. This result may be hastened, toward the end, by placing the flask within the water-bath and sucking out the vapours until they retain not the slightest taste of alcohol. The soap mass should be nearly dry at last, since the removal of all alcohol is essential. Afterwards 50 c.c. of water is added to dissolve the soap, and when *completely* dissolved and cooled the soap is decomposed in the flask with 20 c.c. of dilute sulphuric acid (one of pure strong acid to 10 of water, by volume). The flask is connected with a small but efficient Liebig's condenser, and the contents heated to gentle boiling, bumping being prevented by adding a platinum wire spiral with a bit of pumice-stone on each end (Caldwell's device). The tube connecting the flask and condenser should be moderately wide (about 7 millim. bore) and reach about 3 inches above the flask before bending. This will effectually guard against mechanical carrying over of sulphuric acid, while not causing undue condensation in the tube. Its lower end should be ground slanting. The distillate is to be passed through a small wet filter (to hold back some insoluble fatty acids that come over) and collected in a 50 c.c. flask. As soon as 10 to 20 c.c. has come over it is returned to the first flask, and then the distillation is continued until 50 c.c. has come over. This is *at once* to be titrated with decinormal alkali solution, which is added until litmus solution (4 drops as an indicator) assumes a permanent blue colour, permanent for a few minutes. Phenol-phthalein may also be used.

The potash need not be weighed closer than to about 1 centigramme, nor need unnecessary caution be used as to the strength of the alcohol, but the method is a strictly comparative one, and must not be arbitrarily altered. Duplicate determinations are exceedingly satisfactory by it. The loss by escape of butyric ether during saponification is inappreciable, as experiment proved.

Great differences may result if the sulphuric acid is added before the soap is all dissolved, and blank tests should be made with the potash and alcohol alone, to determine what acidity in the distillate is due to them.

Reichert consumed, on the average, 14 c.c. of decinormal alkali, and never less than 12·5 c.c. His formula for determining the percentage of butter-fat in mixtures is $B = 7{\cdot}3\ (n - 0{\cdot}3)$; n being the number of cubic centimetres of decinormal alkali used in titration.

Meissl (*Dingler's Polytechn. Journal*, 1879, 229) slightly modified the method, especially by using double quantities of fat, &c. His results agree essentially with Reichert's, but the writer regards his modifications as cumbersome and unnecessary. Ambühl (Wagner's *Jahresbericht*, 1881, 839) used 14·05 to 15·55 decinormal alkali for 2·5 grms. of fat; Medicus and Scherer (*Fresenius' Zeitschrift*, 1880, 159) recommend the process. They, as well as Meissl, observed that the more fusible part of genuine butter, separated from the rest by partial cooling, might yield higher figures; 17·3 c.c. instead of 14 c.c., in one experiment.

Sendtner (*Wagner's Jahresbericht*, 1883, 979), by Meissl's method, obtained as a range through a year's time, figures varying from 24·25 to 32·25, the lowest results in February and July. He would place the lowest limit at 24 c.c. (or by Reichert's method 12 c.c.), but would not at once condemn a butter requiring 23 to 23·5 c.c. (11·5 to 11·75 by Reichert).

The writer's results also corresponded with Reichert's, ranging from 12·9 to 14·5 on butters made by himself. Oleomargarine butters gave from 0·4 to 1·55 c.c. Reichert obtained for rape-seed oil 0·25 c.c.; for lard 0·3; for kidney fat 0·25.

Beckurts (*Pharm. Centralhalle*, 1883, 557), following Reichert's method, used from 15·6 to 17·5 c.c. of decinormal alkali, and thinks Reichert's standard too low. His results are unique, and, in the writer's opinion, need confirmation. A. Hanssen (*op. cit.*) and E. Reichardt (*Archiv der Pharmacie*, 222, 1884, 93) also confirm Reichert's figures. Reichardt's experiments were with cows of Dutch breed, using every variety of fodder, and his tests included butter made in every month of the year. He also states that Birnbaum, in Baden, never required less than 13 c.c. decinormal alkali, at whatever season of the year.

Munier alone (*Fresenius' Zeitschrift*, 1882, 394) has proposed to lower Reichert's standard, or, at least, the standards of Meissl and Sendtner. He worked on butters at Amsterdam, Holland, and concluded that the standard should vary for different months. His lowest standard would be 10 c.c. from October to March; but he found in December one butter as low as 9·2 c.c. Why did he not at once propose to lower the standard to 9.2 c.c. for December at least?

Munier's figures are not reliable, because he varied from Reichert's method; especially in using very much less alcohol, and also weaker. Moreover he decomposed the soap with phosphoric acid solution. He called his modifications unessential, but Sendtner (*loc. cit.*) rejects his results altogether, and Reichardt also condemns his deviations, unsupported as they were by published comparative tests to prove that they yielded results identical with Reichert's original method.

Direct comparison of Reichert's and Munier's methods were instituted in the laboratory under the writer's charge.

With phosphoric acid prepared from glacial acid by long boiling with water, extremely low figures, often as low as 6 or 7 c.c., were obtained. With Merck's phosphoric acid better results were obtained, but all fell from 1·1 c.c. to 0·2 c.c. too low, except in one instance where there was only a difference of 0·05 c.c. Six butters were so tested. Munier's figures cannot be received as conclusive until they have been confirmed by further tests.

The essential feature of Reichert's process is the limited fractional distillation. To distil so long as any acid comes over would be to lose the whole advantage of Reichert's process. Cocoa-nut oil yielded to the writer, by Reichert's method, a distillate requiring 3·5 c.c. of decinormal alkali. On adding 50 c.c. more of water to the decomposed soap solution, and again distilling off 50 c.c., a distillate was obtained requiring 2·3 c.c.; repeating the addition of 50 c.c. of water and again distilling off 50 c.c., 1·5 c.c. of decinormal alkali was required; the fourth trial gave 1·4 c.c.; the fifth, 1 c.c.; the sixth, 0·9 c.c., and at this point the experiment was stopped. A genuine butter similarly treated required for the first distillate of 50 c.c., 13·6 c.c. of decinormal alkali; for the second, 1·65 c.c.; for the third, 0·45 c.c., for the fourth, 0·25 c.c.,

at which point the experiment was stopped. No further argument seems necessary for adopting Reichert's plan.

The writer is convinced that Reichert's is the only one of the three methods mentioned that is with any practical degree of accuracy capable of distinguishing between cocoa-nut oil, in mixtures or alone, and pure butter fat. It is rational and convenient.

Reichert's method, with a slight lowering of the standard, is applicable to very rancid butters. About one-half pound of butter, which in May gave a distillate requiring 13·8 c.c. of decinormal alkali, was kept in a loosely-covered jar in the laboratory for eight months, the thermometer rising at times above 90° F. (32° C.). It was then very rancid, smelling like cheese, mouldy on top, and partly changed to a brown mass. An average sample now required 13 c.c. of the decinormal alkali.

NOTICES OF BOOKS.

Chemistry, General, Medical, and Pharmaceutical: including the Chemistry of the British Pharmacopœia. A Manual of the General Principles of the Science and their Applications in Medicine and Pharmacy. By JOHN ATTFIELD, F.R.S. Eleventh edition. London: Van Voorst.

ON opening this book we were struck with the "Advice to Students" here inserted. The writer protests against studying merely by way of "preparation for examination." But he seems to think that a mastery of any subject will enable the student to "pass" with ease and pleasure—an opinion which we by no means share. Dr. Attfield admits that "all authorities on education regard examination as but a partial test of knowledge and an imperfect test of education." He might have added "and as no test at all of mental fertility and of the power of origination." But by way of neutralising the above important concession, he writes:—"It is the best, however, that has been devised." This we cannot admit, as far as the physical sciences are concerned. The reports of professors who have watched the student in their several laboratories will throw a far clearer light both upon his knowledge and his powers than the conclusions of examiners who have seen him only under unfavourable circumstances.

The work before us does not enter into the chemistry of all the elements, those which are of little importance in pharmacy and medicine being passed over. This is perfectly legitimate, but it is scarcely satisfactory to give the name "analytical charts for *all* metals" to tables in which nearly half of them are wanting. By an oversight, no mention is made of the formidably poisonous properties of the chromium compounds, which, as it is well known, are now manufactured and used in the arts on a very large scale.

In the portion of the work which discusses organic compounds we note a few defects. Thus, carmine is said to be "carminic acid united with 1 or 2 per cent of alumina, or occasionally of oxide of tin or albumen." C. Liebermann considers that the tin and traces of copper when present are derived from the vessels in which the cochineal has been boiled, whilst alumina and lime are present, each to about 3½ per cent.

Under "Cantharidine" we note a clerical or typographical error. *Mylabris cichorii* is given as *Mylatris*.

The short section on colouring matters—which, of course, are but of secondary importance to the pharmaceutist—is not quite free from error. Thus fustic is said to be the wood of *Rhus cotinus*. In fact it is yielded by *Morus tinctoria*, the product of *Rhus cotinus* being known as young fustic, or fustet, and giving different results with mordants and other reagents. The best quality of Persian berries are the product, not of *Rhamnus infectorius*, but of *R. amygdalinus*, *R. oleoides*, and *R. saxatilis*.

We cannot admit that cam-wood contains probably the same substance as Brazil-wood and sapan. It has not, indeed, been, as yet, thoroughly examined, but in its behaviour it approximates to sanders-wood and barwood, which yield colouring matters less soluble in water and more permanent than those of the softer red woods.

Under indigo we read that it is "now produced artificially" These words might be misunderstood as meaning that the ordinary indigo of commerce is thus obtained. Bayer's artificial product cannot compete in the market with the natural article.

We are unable to endorse Dr. Attfield's remarks on methylated spirit. He speaks of it as "a spirit issued, duty free, for the use of manufacturers, the methylic alcohol, &c., not interfering with technical applications." This, unfortunately, is not the case. The impurities in wood-spirit, which the revenue officials do not allow to be eliminated, interfere with the tinctorial uses of the spirit, and still worse is the presence of shellac, which is insisted upon unless the consumer can find heavy security that the spirit shall be used merely for the purposes specified.

But, passing over these points, which after all little affect the main object of the book, we must pronounce it most satisfactory, both for its comprehensiveness and its accuracy. We are glad to note that the microscopic characters of certain organic bodies and mixtures, such as the starches and urinary sediments, are carefully described and illustrated by well-executed figures.

In fine, Dr. Attfield must be complimented on the care and patience which he has evidently brought to bear on his task. We are particularly struck with the thoroughness, and—so far as we have been able to test it—the accuracy of the index. Having had some experience in indexing, we are the better able to appreciate this feature.

Studies from the Laboratory of Physiological Chemistry, Sheffield Scientific School of Yale College. For the year 1884-1885. Edited by R. H. CHITTENDEN, Ph.D., Professor of Physiological Chemistry. New Haven: Tuttle, Morehouse, and Taylor.

THIS work marks a sound and energetic scientific activity. Professor Chittenden is evidently initiating his students in research by the German method of associating them with himself in original investigations. The efficacy of this plan, which is in fact the key-stone of the German university system, does not require to be here expounded.

The questions here examined are the diastatic action of saliva as modified by various conditions, studied quantitatively; the amylolytic action of the diastase of malt is modified by various conditions; the influence of certain therapeutic and toxic agents on the amylolytic action of saliva; the influence of various inorganic and alkaloid salts on the proteolytic action of pepsin-hydrochloric acid; the influence of certain therapeutic and toxic substances on the proteolytic action of the pancreatic ferment; the influence of temperature on the relative amylolytic action of saliva and malt-diastase: the influence of bile, bile salts, and bile acids on amylolytic and proteolytic action; the absorption of arsenic by the brain; the influence of potassium and ammonium bromides on metabolism; the influence of cinchonidine sulphate on metabolism, and the post-mortem formation of sugar in the liver in presence of peptones.

The inquiry into the absorption of arsenic by the brain are of great importance from a toxicological point of view. The authors succeed in confirming the conclusion of Scolosuboff, that arsenic when taken in a very soluble and diffusible form, such as sodium arsenite, accumulates in the brain. On the contrary, when the poison has been taken in the form of arsenious acid or copper aceto-arsenite (Paris green), which are very sparingly soluble,

mere traces are discovered in the brain. Hence in poisoning cases, where the symptoms indicate the possible presence of arsenic, the brain ought to be specially and distinctly examined. If arsenic is there recognised it may be regarded us strong evidence that the poison has been administered in some soluble form. Two recent cases, which the authors append in illustration, show that in acute poisoning from the ingestion of large doses of insoluble arsenical compounds, mere traces were found in the brain. In one case, whilst 12·78 m.grms. arsenious acid were obtained from the liver, and 3·40 m.grms. from the kidneys and bladder, the brain yielded only 0·2 m.grms.

One question the authors do not appear to have decided: if arsenious acid has been administered in small successive doses, in what proportion will it be found in the brain? Such cases in human subjects are very rarely met with, but in America experiments on the lower animals have not been prescribed by law, and the authors might therefore with advantage undertake the decision of this point.

Workshop Receipts. Fourth Series. By C. G. Warnford Lock. London: E. G. Warnford Lock.

This fourth and final series of "Workshop Receipts" is, as we are informed in the preface, devoted mainly to subjects connected with handicrafts and mechanical trades, and consequently falling to a great extent outside the boundaries of our legitimate cognisance. This is eminently the case with bookbinding, straw plait, matting and basket-making, repairing pianos, harmoniums, and musical boxes, clock- and watch-mending, &c. Indeed, it is doubtful in how far instructions for repairing clocks and watches can be looked upon as receipts. Few persons, we think, will undertake, and still fewer will succeed in such tasks, unless they have formally learnt the trades in question, when they will have little need of printed instructions.

But there is also matter which falls within the province of the chemist. There is an article on distillation viewed with reference to the purification of water from fixed impurities, to the preparation of tinctures and extracts, and to the rectification of those forms of ethylic alchohol popularly known as "spirits." A figure and a portion of letter-press are devoted to the apparatus used in Neufchatel for the manufacture of that poisonous concoction absinthe.

Desiccation is treated of both as a scientific and as a technical operation. It is strange, however, that we find here no mention of the Gibbs drying machines, which are now in successful use at the Government gun-cotton works at Waltham Abbey. We are not sure, however, whether some of the processes here described are not adaptations of some of the expired patents of the inventor.

The various pumps used in raising acids, alkaline lyes, liquid soaps, syrups, &c., are described and figured at some length.

Embalming, as applied to human bodies, little requires to be taught; indeed were it at all general it would require to be seriously untaught. But the instructions for preserving anatomical specimens are trustworthy and valuable.

"Packing and Storing" is the title of a chapter of much more interest and importance than it might at first glance be expected. It is startling to find that very large quantities of Assam tea sent to this country have been rendered of little value by the nature of the wood employed in making the chests. Some kinds of timber generate acetic acid, which reacting on the wood produces ill-smelling compounds, and not only so, but corrodes the lead lining, thus allowing the aroma of the tea to make its escape.

On filtration we find a lengthy article. The Hyatt, Atkins, Sawyer, the silicated carbon, the Bernays, the Spencer, and the Bischof filters are all described. Concerning the last-mentioned, or spongy iron filter, the author expresses himself rather too confidently: eminent authorities maintain that water thus filtered is by no means free from bacteria and other micro-organisms. Mention is also made of Chamberland's earthenware filter, which is, for certain purposes, the most efficient of all.

As regards laboratory filtration it is remarked that English manufacturers do not seem to have turned their attention to the preparation of a superior filter-paper. Munktell's Swedish and Schleicher and Schull's German papers are still preferable to anything produced in this country.

As regards the magnesia process for softening water on the large scale we entertain a doubt. If the magnesia passes into solution its presence for some technical uses, and certainly for dietetic purposes, will be more objectionable than the original calcium salts.

The entire series of "Workshop Receipts" merits, and will doubtless command, a large circulation.

Thirteenth Annual Report of the Director of the Mint, 1885. Washington: Government Printing Office.

From this report we learn that the estimated total production of gold in the world for the year 1884, calculated in American money, was 95 millions, and of silver 115 millions. This is an increase of about a million in gold over the production of 1883, and a falling off to about the same extent in the production of silver. The yield of gold is about 4½ millions less than it was in 1882.

The total coinage of the world is given as 99½ million dollars in gold and 90 millions in silver. The consumption of gold for coinage alone is thus greater than the year's supply. The total value of the gold coinage of the United States is given as close on 24 millions, and the silver coinage is 28½ millions. The gold coinage of Russia is given as nearly 20 millions, that of Germany 14 millions. The total gold coinage of the British empire is 33 millions, viz., 11 millions in England, and 22 millions in Australia.

Price-List of Chemical and Scientific Apparatus and Pure Chemicals sold by Baird and Tatlock. Glasgow: Crown Buildings, Sauchiehall Street.

We have here a copious and well-illustrated catalogue of apparatus, chemical and physical, electrical appliances figuring very prominently. Of balances Messrs. Baird and Tatlock seem to keep a large assortment in stock, of the makes of Oertling, Bunge, and Becker. They have also a large assortment of the gas-furnaces, stoves, blowpipes, &c., devised by Fletcher, of Warrington.

In looking over the list of chemicals we find mention of some substances not to be obtained from every dealer in reagents, *e.g.*, phenol-phthaleine. We notice, with some surprise, that "fuchsine" figures here not as an objectionable Franco-German synonym for the English name "magenta," but as a distinct substance. At least "fuchsine" is quoted at 2s. 6d. per ounce, and magenta at 9d.

Diaries for 1886. London: Letts, Son, and Co., Limited.

Again we have pleasure in drawing attention to the useful little publications of this firm. The pocket diaries, which are published in numerous sizes and shapes, and of different prices, contain, in addition to the usual diary spaces for entering notes and engagements, much information which if correct cannot fail to be useful, if the owner of the pocket book only remembers where to find it. Thus the Gentlemen's Pocket Diary contains, amongst other items, information about Passports, Property Tax (given at the pleasant figure of 6d. instead of 8d.), Rates, Inland

Revenue Duties, Eclipses, The Cabinet, British Customs Tariff, Stamp Duties, British and Foreign Postal Tables, Foreign Telegram Time Table, Weights, Measures, Wages, How to make a Will, Middle Class Hospitals, Tide Tables, Weather Forecasts, a complete list of members of the *late* House of Commons, &c.

The Metallic Diary, although too small for most purposes, will be useful for note taking, as the marks with the metal stylus will not rub out like ordinary pencil marks. It is not generally known that on this prepared paper writing can be effected with any silver or gold coin in default of the prepared pencil supplied with the book.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—May I be allowed space for a few lines on the subject of the three years' collegiate training required by the Institute of Chemistry.

I venture to think that I am expressing the opinion of the majority of analytical chemists, when I say that this compulsory training is a great hardship to many of us, and is due to a most short-sighted and mistaken policy on the part of the Council. My own case I believe to be somewhat hard, for I have been articled for five years to an analyst with a large practice, and have therefore acquired considerable practical knowledge, and yet find myself debarred even from submitting my knowledge to the required test.

Your correspondent of the 26th instant, writing under the *nom de plume* "Ferrum," and whose case is similar to my own, said that, on applying to the secretary, he was told that the Council of the Institute insisted on the evidence of three years' training. On laying my own case before the secretary, I was even more unfortunate than "Ferrum," for no notice was taken of my letter. Cannot the Council see that the best interest of the chemical profession would be served by the abolition of the college training, and the substitution of an examination which would be a fair test of both practical and theoretical knowledge, and which would be available to any chemist?

Another grievance is that it is simply the accident of birth that shuts many men out, as prior to October, 1883, any man who had arrived at the age of 21 could, on producing certain certificates from the Science and Art examinations, sit for the A.I.C. without any collegiate preparation. Let us hope that the many letters which have already appeared on this subject will appeal with good result to the Council of the Institute of Chemistry.

I enclose my card, and am, &c.,

J. W.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxiv., Part 4, 1885.

Action of Chlorophyll upon Carbonic Acid outside the Plant Cell.—P. Regnard.—The chlorophyllian granules continue to decompose carbonic acid, even when separated from the plant cell. Chlorophyll separated from protoplasm acts also, although with a very feeble intensity.

Determination of Sulphur in Organic Compounds.—E. H. Keiser.—The author criticises Liebig's process.

Volumetric Determination of Acetic Acid and its Salts.—C. O. Weber.—The author heats 10 grms. of the acetate finely ground with a little water in a 50 c.c. flask, fills it up to the mark, and filters the liquid through a dry folded filter. 25 c.c. of this solution are mixed with 50 c.c. absolute alcohol, and the acetic acid is precipitated with an alcoholic solution of silver nitrate. The precipitate of silver acetate is filtered, well-washed with 60 per cent spirit, dissolved in hot dilute nitric acid, and titrated with decinormal sodium chloride. Each c.c. of this solution consumed represents 0·006 grm. acetic acid hydrate.

The Melting and Congealing Points of Mixtures of Phenol and Paracresol.—G. Lunge.—The author gives his results in the form of a table.

The Influence of Basic Lead Acetate on the Determination of Sugar by Polarisation.—P. Degener.—Basic lead acetate modifies the rotatory power of a number of bodies existing in beet-juice. The error thus occasioned is diminished by the addition of 0·3 volume of absolute alcohol.

The Volumetric Determination of Sugar with Fehling's Solution.—F. Meyer.—To occasion a quick settlement of the cuprous oxide the author adds, towards the end of the operation, a little zinc chloride.

Determination of Starch in Grain and Potatoes.—M. Maercker.—The author heats 3 grms. of the finely ground sample to 90° with 50 c.c. of water. When it has cooled down to 65° he adds 5 c.c. of a cold extract of malt. After half an hour he adds 10 c.c. of a 1 per cent solution of tartaric acid, and heats in a brass vessel up to a pressure of 4 to 5 atmospheres. When the liquid has cooled down to 65°, 5 c.c. more malt extract are added, and after another half hour the mixture is again heated for two and a half hours to 100°, with the previous addition of 15 c.c. hydrochloric acid and 150 c.c. water. The solution is then neutralised, and the dextrose formed is determined by Allihn's method.

Analysis of Wine.—W. Lenz.—A great number of processes for the determination of various constituents and possible impurities. It is remarked that blood decolourised by means of sulphurous acid displays no absorption-bands when examined with the spectroscope.

The Examination of Honey.—Attention is called to the fact that bees convey into their cells not merely the nectar of flowers, but the so-called "honey-dew" from the leaves of plants. Honey containing such an admixture behaves as if adulterated with starch-sugar.

Examination of Fats.—R. Bensemann.—The author has investigated the melting points of fats, and tabulates his results.

The Quantitative Determination of the Cinchona Alkaloids.—Y. Shimoyama.—The author concludes that De Vrij's method for determining quinine in presence of other alkaloids is to be rejected. Hielbig's method for separating quinine from cinchonine is useless, but it may serve to separate quinine from mixtures containing no other alkaloids. He considers that all attempts to determine quinine in presence of cinchonidine as herapathite are in vain. The author's own method will be inserted in full.

Liquid Carbolic Acid.—This compound is supposed to be a mixture of crystalline phenol with 10 per cent of water. Sohlickum proposes to determine the proportion by mixing 10 c.c. of the sample with 10 c.c. of water at 20°, and, when the mixture has settled, reading off the volume of the lower stratum.

Determination of Nitrogen in Human Urine.—E. Pflüger and K. Bohland.—For the determination of the nitrogen the authors find their favourable opinion of the Kjeldahl process confirmed. They are of opinion that

the use of sodium sulphite, potassium iodide and iodate as indicator, is far preferable to litmus. They reject the use of starch entirely. They point out, as a possible source of error, the presence of ammonia in commercial sulphuric acid.

The Determination of Sulphur in Proteine Compounds.—According to Hammarsten losses are often experienced in performing Löw's process. Löw replies that such losses occur only when the mixture is pressed closely into the platinum crucible instead of being permitted to lie more loosely.

Determination of Uric Acid.—Salkowski has improved upon his original process. In the measured sample he removes the phosphates with magnesia mixture, and then precipitates the uric acid with a solution of silver as a silver-magnesium double salt. On decomposing this precipitate with hydrogen sulphide, and concentrating the filtrate, which is acidulated with hydrochloric acid, the uric acid is obtained in a crystalline state.

Animal Gum in Urine.—H. A. Landwehr.—Animal gum is a normal constituent of human urine. The author mixes the urine with copper sulphate, and adds soda-lye in large excess. The blue flocks are filtered off, washed with water, dried, and dissolved in a minimum of hydrochloric acid. On adding 3 vols. of absolute alcohol, and heating to 60°, a fine precipitate appears, which is animal gum. Landwehr believes that Thudichum's cryptophanic acid and Béchamp's nephrozymase consist chiefly of this gum.

Behaviour of the Biliary Acids with Glue and Glue-Peptone.—According to F. Emich glykocholic acid precipitates neither glue nor glue-peptone from solution. But if to a solution of glue there is added taurocholic acid, or a taurocholate and hydrochloric acid in slight excess, the glue is separated out quantitatively.

Researches on the Number of Blood-Globules and on the Quantity of Hæmoglobin in Blood.—J. G. Otto.—The details of the author's researches are not given.

Albumenoids of Milk.—J. Sebelien.—There are at least two albumenoids present in milk along with caseine, lacto-globulin and lactalbumen.

Detection of Oxydimorphine.—W. Marme.—The author gives, in a series of tables, the behaviour of this alkaloid as compared with morphine, apomorphine, and codeine.

Equivalents of Carbon, Phosphorus, Tin, and Zinc.—J. D. Van der Plaats.—For carbon the author obtains values quite in accord with those of Stas and Dumas, and of Roscoe. For phosphorus he finds numbers ranging from 30·90 to 31·08. Tin gave values from 118·01 to 118·14, and zinc 65·14 to 65·21.

Monteur Scientifique, Quesneville.
Series 3, Vol. xv. December, 1885.

Method for Preventing Rabies after a Bite.—L. Pasteur.—A medical paper, read before the Academy of Sciences and the Academy of Medicines.

On Acridine.—M. Bernthsen.—Translated from *Liebig's Annalen.*

The Action of Diazo-Compounds on β-Naphthylamine.—F. A. Lawson.—The product is a red crystalline body, forming rhombic tablets insoluble in water, fusible at 102°-104°, and not decomposed on boiling with alcoholic potash. If boiled with dilute sulphuric acid (20 per cent) it loses nitrogen and is split up into phenol and β-naphthylamine.

On Crystalline Methyl-Violet.—A. W. Hofmann.—The author obtains this product by acting on dimethylaniline in presence of aluminium chloride, with chlorinised methyl-formic ether. Hexamethyl para rosaniline hydrochlorate is thus obtained in hexagonal crystals of a coppery lustre.

A New Class of Colouring Matters.—O. N. Witt.—On heating the amido-azotoluene derivative of paratoluidine with the hydrochlorates of the primary aromatic amines, there is a very complicated reaction which generates colouring matters.

On Indigotine Dicarbonic Acid.—W. Loew.—The author has prepared carboxylic derivatives corresponding to the sulphone derivatives of indigo.

On Bresiline.—MM. Buchka and Erck.—These chemists obtain pure bresiline by the following process:—They dissolve 10 parts of commercial bresiline in a little alcohol, and add to the solution 400 parts of ether. The ethereal solution is then mixed with five parts of strong nitric acid. The liquid is let stand for 36 hours, and is then exposed to spontaneous evaporation. The bresiline is deposited in the form of brilliant laminæ, which are washed with cold water until the acid reaction disappears and then with boiling alcohol. Oxidising agents entirely destroy bresiline. Nitrous acid converts bresiline in acetic solution into tri-nitro-resorcine, though the greater part of the product is destroyed.

Patents on Colouring Matters Obtained at Berlin.—These patents relate to the preparation of tetraiodopyrrol, to the preparation of a colouring matter and a mordant with catechu, to quinoleic compounds obtained by heating amidic aromatic substances with mixtures of aldehyds and acetones, to violet and blue azo-colours resulting from the reaction of tetrazoditolyl or its salts upon the naphthols or their sulphonic acids; the preparation of substituted benzoic aldehyds, and to an improvement in the preparation of β-naphthol γ-sulphonic acid.

On Cochineal and Carmine.—C. Liebermann.—Carmine does not, as stated in the text-books, consist of carminic acid "combined with small quantities of alumina and lime," for the quantities are not small. It is a nitrogenous body containing 3·7 per cent of nitrogen in the dry substance. The best samples sold as "carminnaccarate" contain—Water, 17 per ct.; proteic matter, 20; ash, 7; colouring matter, 56; wax, traces. The ash contains 43·09 per cent of alumina, 44·85 per cent of lime, besides soda, potash, and phosphoric acid to the amount of about 3 per cent each. In the ammoniacal solution of carmine the alumina and the lime are completely masked, so that ammonium oxalate determines no precipitate. Carmine offers a remarkable analogy to the aluminic lake of alizarin or purpurin, into which lime and an organic compound—emulsive oil—enter also as components.

The Wax and the Fatty Matters of Cochineal.—C. Liebermann.—The wax in question, coccerine, is distinguished from all known waxes by its properties and its elevated melting-point.

The Manufacture of Glucose.—From the CHEMICAL NEWS.

Patents on the Chemical Arts taken out in France.

Selection of Patents Connected with the Chemical Arts.—These two lists both contain French patents for October last.

Electric Furnace for the Reduction of Refractory Minerals.—T. S. Hunt.—From the CHEMICAL NEWS.

The Germs of Yeast in Bottled Beers.—Taken from the *Journal des Brasseurs*, but originally a translation from the *National Bottlers' Gazette.*

On the Action of Soluble Phosphates on the Rootlets of Plants.—Jules Joffre.—The author shows that, though strong solutions of soluble phosphates injure the rootlets of plants, weak solutions, such as alone occur in agricultural practice, have no such action.

Manufacture of Liqueurs and the Crystallisation of Sugar.—Julius Krüger.—In this paper, which is credited to the *Revue de la Distillerie*, but which seems to

be of German origin, the author points out the objections to the use of glucose syrups as a substitute for, or a sophistication of, cane-sugar.

Prizes offered by the Swiss Society of Chemical Industry.—A prize of 1200 francs is offered for an improved apparatus for determining the value of fuel; preferably it should be capable of operating upon several kilos of the combustible. A prize of 300 francs is offered for an improved arrangement of bleach and dye-works, showing methods of lighting, ventilation, and heating. Arrangements are desired for preventing internal fog in winter, the condensation of water on the inside of the roof, and the rusting of the iron-work. Memoirs, written in French or German, to be sent to M. Jenny Studer, of Glaris, up to December 31st. 1886, each marked with a device or motto, and accompanied by a sealed envelope containing name and address of writer.

Justus Liebig's Annalen der Chemie,
Vol. ccxxx., Part 2.

Studies on the Methylene Blue Group.—August Bernthsen. (Continuation).—This bulky memoir does not admit of useful abstraction.

On Nitrogen Iodide.—F. Raschig.—Several distinct, though unstable, compounds have been included under the name nitrogen iodide. The existence of a tri-iodamine has been definitely established, but mono-iodamine is still doubtful.

Behaviour of certain Organic Nitrogen Iodides.—F. Raschig. The author describes di-iodmethylamine and ioddimethylamine and the corresponding ethyl compounds.

On the Terpenes and the Ethereal Oils.—O. Wallach. (Third Treatise.)—The author here discusses borneol, camphene, the so-called "borneen," sylvestreene, Russian oil of turpentine, terpinol, terpinene, terpinolene, and terpineol. His principal results are that borneol, melting at 206°, behaves in general like a saturated secondary alcohol, but it forms with bromine and with halogenous hydracids instable double compounds. Camphene is formed directly from borneol by the action of dehydrating agents. Borneen is a mere mixture of the decomposition products of camphene. The Swedish and the Russian oils of turpentine are identical in composition. They consist essentially of a mixture of pinene, sylvestrene, and dipentene, probably along with terpinene. The characteristic ingredients of both these oils is sylvestrene. Terpinol, as described by Wiggers and List, does not exist. Terpineol is a non-saturated monatomic alcohol. Terpinene has the same melting-point as dipentene, but yields, on bromination, liquid products. The author arranges the terpenes which he has examined in two parallel series, whose corresponding members agree in their boiling points. I. Pinene, sylvestrene, terpinene. II. Camphene, limonene, dipentene, terpinolene.

Journal de Pharmacie et de Chemie.
Series 5, Vol. xii., No. 10, November 15, 1885.

Method of Preventing Rabies after a Bite.—L. Pasteur.—This paper has no chemical bearings.

Apparatus for the Rapid Determination of Dry Residues.—M. Yvon. This apparatus, which combines the action of heat and of a vacuum with the absorbent power of sulphuric acid, cannot be intelligibly described without the accompanying illustration.

On the Toxic Product extracted from pure Cultivations of the Comma Bacillus, and its Comparison with that extracted from the Bodies of Cholera Patients.—W. Nicati and M. Rietsch.—The authors have obtained a ptomaine, which is apparently due to the cholera-bacillus, and which is found to produce, when injected into the bodies of animals, all the symptoms of cholera.

Note on the Chemical Verification of the Purity of Butters.—A. Andouard.—The author, whilst recognising the value of the process of MM. Hehner and Angell—determination of the fixed and insoluble fatty acids, and that of Lechartier—the determination of the soluble and valuable fatty acids—considers that the interpretation of the results is sometimes difficult on account of the uncertainty of the limits presented by pure butters from different localities. He finds that pure butters from Bretagne may contain more than 89 per cent of pure fixed fatty acids.

Hopeine.—This compound is a narcotic alkaloid extracted from the hop. It forms white crystalline needles, very sparingly soluble in water, but soluble in 50 parts of alcohol; 10 centigrammes would probably be a fatal dose for an adult.

No. 11, December 1, 1885.

On Acid Magenta in Wines. — P. Cazeneuve. — Nine-tenths of the wines fraudulently coloured are got up with this product—the sulpho-conjugated compound of rosaniline. Ordinary magenta may be detected either with lead sub-acetate and amylic alcohol, or with ammonia and ether followed by an acid. The sulpho-conjugated compound cannot be thus discovered. Wines coloured with this compound show, if examined with the spectroscope, two bands, one towards the red and the other at the beginning of the blue of the spectrum. Both disappear if an alkali is added to the liquid. M. Bellier adds to the suspected sample an excess of coloured magnesia, and then there is a small quantity of a 2 per cent solution of mercuric acetate. If the wine is pure the filtrate is colourless, and is not reddened by acids. If acid magenta is present it is thus reddened. A still simpler method is to shake up 50 c.c. of the wine with 50 grms. of manganese peroxide. Natural wines and such as have been coloured with vegetable colours, with the azo-dyes and ordinary magenta, are rendered colourless, whilst the colour of acid magenta is not removed.

On the Determination of the Points of Fusion.—P. Chastaing. — This paper does not admit of useful abstraction.

Qualitative Detection of Nitrates and Chlorates.—M. Behal.—The author bases his method on the property of nascent hydrogen to convert the nitrates into ammonia, and the chlorates into chlorides.

Toxicity of the Oxides of Phosphorus.—M. Schultz.—The hypophosphites are not poisonous. The phosphites are violent poisons, acting on the nervous centres and the abdominal glands. The hypophosphates, meta- and pyrophosphates have a poisonous action on the stomach; the orthophosphate is well known to be harmless. Those phosphorus acids which contain an even number of atoms of oxygen are not poisonous.

MEETINGS FOR THE WEEK.

MONDAY, 11th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 12th.—Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers, 8.
—— Photographic, 8.
WEDNESDAY, 13th.—Geological, 8.
—— Microscopical, 8.
—— Society of Arts, 8. "Museums for Trade Patterns," by William H. Ablett.
THURSDAY, 14th.—Royal, 4.30.
—— London Institution, 7.
—— Philosophical Club, 6.30.
—— Mathematical, 8.

ERRATA.—P. 2, col. 2, line 26 from bottom, *for* "20" *read* "10." Line 2 from bottom, *for* "juice" *read* "zinc." P. 6, col. 2, line 34 from top, *for* "mercurous nitrate" *read* "mercurous sulphate." P. 7, col. 1, line 8 from top, *for* "nitrite" *read* "nitrate."

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THE CHEMICAL NEWS.

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COMMERCIAL TREATMENT OF ROMAN ALUNITE.*

By M. P. GUYOT.

The *Chemische Industrie*, No. 2, 1885, p. 50 (*Ber. Chem. Ges.*, vol. xvii., p. 2888; *Chemiker Zeitung*, vol. ix., No. 20, 1885, p. 361) has analysed some work of M. C. Schwartz on the calcination of Roman alunite, and the determination of the best strength of acid to use to obtain complete solution of the alumina and the potash. The author arrives at this conclusion—that calcination at 500° is preferable to that obtained at lower temperatures, and that acid at 33° Baumé dissolves the alumina and the potash better than acid at a higher degree of concentration.

The work of M. Schwartz only confirms the observations that we published some years ago (*Comptes Rendus*, vol. xcv., p. 693, 1001, and *Journ. de Pharm. et de Chim.*, 5th series, vol. vi., p. 337) at the completion of some commercial trials that we made in 1879 and 1880.

Alunite contains two products important in the manufacture of alum:—

1. Alum and sulphate of alumina (basic).
2. Free alumina.

The heat of the calcination acts first of all on the alumina, which loses all its water of combination; it thus becomes soluble in acids, while the basic salts require a higher temperature before becoming soluble in their turn. Furthermore, alumina submitted to a high temperature becomes insoluble in acids; therefore its solubility in these agents depends on the temperature it has been submitted to. It follows that if, on the one hand, we wish to obtain all the free alumina soluble in acids (which we can do with a moderate temperature) we have, on the other hand, a loss of natural alum in the insoluble state. It is necessary therefore, for calcination, to be guided by the experience which, according to analysis, gives the least loss of these products, as well as causing the least expense for calcination.

To find the most favourable temperature we made four experiments, in each case using the crude powder finely sifted, and of the following composition:—

Potassic sulphate	14·00
Aluminic sulphate combined with potassic sulphate	26·55
Free aluminic sulphate	6·56
Free anhydrous alumina	18·58
Water	11·90
Ferric peroxide	0·80
Siliceous residue	21·61
	100·00

The following table gives the analytical results of minerals calcined at different temperatures. (See next col.)

By inspecting this table it is easy to see that a calcination at 800°, or between 800° and 900°, gives very superior results to those obtained at lower temperatures,

	Experiments on 100 tons calcined in quantities of 625 kilos			
Temperature	600°	700°	800°	900°
Duration of calcination	5½ h.	3 h.	3 h.	1¾ h.
Loss in calcination, per cent	16·87	16·82	19·06	16·96
Percentage composition of the calcined mass:—				
1. Soluble potassic sulphate	7·64	8·50	15·00	12·0
2. Anhydrous sulphuric acid from the soluble aluminic sulphate	8·00	7·92	11·10	11·62
3. Anhydrous alumina from the *quantum* of soluble potassic sulphate	4·49	4·99	8·85	7·04
4. Anhydrous alumina in excess, soluble in acids	23·00	20·16	24·00	23·00
5. Insoluble potass. sulphate	7·56	7·02	1·80	4·28
6. Insoluble alumin. sulphate	14·84	14·99	3·52	8·30
7. Alumina in excess, insoluble in acids	—	3·60	—	—
8. Ferric peroxide	1·00	1·00	1·00	1·00
9. Siliceous residue	33·47	31·82	34·73	32·76
	100·00	100 00	100·00	100·00

even when this roasting is prolonged by more than two-thirds.

The final yield in alum varies according to the two following causes:—

1. Concentration of the acid employed.
2. Quantity of acid used.

In rapid work, to dissolve in a commercial manner all the anhydrous alumina of the calcined mineral, and to prevent in the clay ovens the formation of basic aluminic sulphate, it is indispensable to carry on the operation with a large excess of sulphuric acid over a quantity theoretically required. To determine what this excess should be we made several experiments with a mineral requiring 800 kilos. of acid, at 52° to 53° Baumé, per ton, and we successively employed for 8000 kilos. of powder, 7, 8, 8·8, and 9·8 tons of acid at 52°. All the trials were conducted in the following manner:—The acid having been poured into the clay oven, and reduced to 30° Baumé, the attack was commenced between 80 and 90° C. The calcined powder was added to the acid by several instalments, the liquid mass being stirred so that the reaction might proceed regularly. After the addition of all the powder two hours are allowed to complete the reaction; then, after concentrating the liquid by bringing it to 38° Baumé, the potassic sulphate is added. This operation, from the commencement up to the complete solution of the sulphate, lasts about ten hours. It is then left thirteen hours to settle, when the clear liquid is drawn off. This liquid is about 41° to 42° Baumé, a point which must not be exceeded, or we should not be able to clarify the three-quarters of the liquid, the last quarter only remaining muddy.

The muddy portion is reduced to 24° Baumé by the addition of mother-liquor; after well stirring it is again left. When the liquid is clear it is drawn off into the vat where the first lot is. After one day settling the matter becomes quite cool; the deposited alum is taken out and refined.

The operation at 24° Baumé has still left a thick portion and a siliceous residue. The liquid is drawn off into a brick tank, where the alum is allowed to crystallise. A further quantity is obtained by washing the residue.

For the four roastings which served for our experiments we used calcined powder of uniform richness.

The crude mineral contained 12·5 per cent of potassic sulphate; the loss by calcination was 22 per cent, of which 9·88 per cent was sulphuric acid.

* Communicated by the Author, with the following letter:—

"Monsieur,

"L'intéressante note de M. Spencer Umfreville Fickering, sur le sulfate d'alumine que vous avez publiée en 1882 dans le Chemical News, m'engage à vous soumettre l'étude que je viens de terminer sur la fabrication de l'alun au moyen de l'alunite de la Tolfa. Voulez vous lui accorder l'hospitalité des colonnes de votre journal?

"P. Guyot, Chimiste;

"Nancy, 17 9bre, 1885." Réd. du Repertoire de Pharmacie.

The calcined mineral contained:—

1. Soluble potassic sulphate	13·93
2. Anhydrous sulphuric acid from the soluble aluminic sulphate	9·20
3. Anhydrous alumina combined with sulphuric acid	3·94
4. Free anhydrous alumina	23·06
5. Ferric peroxide	0·60
6. Non-calcined mineral	8·23
7. Siliceous residue	41·04
	100·00

The following are the results of the trials:—

Calcined mineral, 8 tons; sulphate 2·7 tons.

	Sulphuric acid 52° Baumé used.			
	7000	8000	8800	9800
Commercial alum (less 2 % moisture)	2·632	5·285	9·552	10·670
Commercial alum (less 2 % moisture)	0·647	1·157	2·124	2·240
Commercial alum (less 15 % for impurities and loss in refining)	3·523	2·348	4·304	4·483
Alum obtained from the muddy liquid of the 2nd operation (less 18 % for impurities and loss).. ..	0·779	0·820	1·132	1·121
Alum from the mother-liquor from the vat (less 15 % for impurities and loss).. ..	0·449	0·447	0·450	0·449
Total available alum..	8·030	10·057	17·562	18·963
Quantity obtained per ton of calcined ore	1·003	1·257	2·195	2·3704

Analysis of the residue:—

	Per cent of Calcined Ore. Operation at			
	7000	8000	8800	9800
Anhydrous alumina not attacked	15	10	5	3
Insoluble potassic sulphate	2·35	2·20	2	2·01

In the operations with 7 and 8 tons of acid the alumina is nearly all found to be in the state of basic sulphate. In each trial mother-liquors of known richness were used, and their value was taken into account in the calculations.

It must be noted that the excess of acid used in attacking the ore eventually remains in the mother-liquor. These liquors being used over again are beneficial to the following lots.

If, however, instead of an ore containing 12½ per cent of potassic sulphate one had been used containing—as is sometimes the case—14 per cent, the price would be less, the expense being the same for treating rich or poor ores.

From the two preceding tables we see that the yield of alum obtained in the four lots is far from what it theoretically should be, especially in those cases where we have used a small quantity of acid, although more than theoretically necessary. The calcination at 800° or 900° C., besides the anhydrous alum, still contains some anhydrous alumina which resists the action of the acid when it has been recently used. The anhydrous alum is insoluble in water if it has not undergone previous hydration, which is generally slow in its action: it is for this reason that the residues containing potassic sulphate, which in spite of ten hours' maceration remain unhydrated, are insoluble.

Part of the alumina becomes at a high temperature insoluble in acids, which is only overcome by prolonged maceration in acidulated water. In ten hours all the alumina is not entirely dissolved; therefore the residue always contains more or less according to the excess of acid used, this latter favouring the modification or transformation of the alumina from the insoluble to the soluble state.

However, the excess of acid to be employed has a limit, which should be determined according to the richness of the ore. From fresh trials made with a roasted ore obtained from the crude ore, containing 14·5 per cent of potassic sulphate, we have decided that the excess of acid should not be more than 9800 for 12·5 of potassic sulphate. The results are satisfactory, and the settling rapid with a quantity proportionably less, which tends to prove that the potassic bisulphate formed aids the solution. Having to try a rich ore, and basing our plans on the formula 9800, which gave the best results with the poor powder, we should have to use 15·12 tons of acid at 52° or 53° Baumé; now, having used only 12·5 tons of acid for the attack, we obtain a very good result, 2·37 times the weight of the powder used. It should be noted that for this rich ore the theoretical quantity is 10·664 tons of acid at 52° Baumé for 8 tons of calcined ore.

At the moment of roasting the composition of the mass should be found, and the quantity of acid to be used decided on, according to its richness in alkaline sulphate, keeping account of the quantity of acids in the mother-liquors which will be used during the working up of the material.

The mother-liquors, which gradually become very impure, at length affect the purity of the alum; they represent a great loss of acid, which could be prevented by a prolonged maceration of the ore. It is this which has given rise to the operation of *Camelotte** that we have described (*Comptes Rendus*, vol. xcv.); the maceration in an acid liquid causes the necessity of expense in labour, of time, plant, &c. Furthermore, when it is necessary to change the macerated and moistened ore to the attacking ovens, we experience difficulties which make us give up this method of working, for we must not think of leaving the clay ovens quiet for several days, or even a week, while performing the maceration, for the sediment would solidify at the bottom and close up the openings of the steam-pipes, and cause explosive projections on resuming the operation.

To conclude, the best process consists in recovering the acid by the preparation of secondary products, impure it is true, but which might be found useful in certain industries.

CHEMICAL AND MICROSCOPICAL STUDIES ON THE ACTION OF SALICYLIC ACID ON FERMENTS.†

By Dr. A. B. GRIFFITHS, F.R.S.E., F.C.S. (Lond. and Paris).
Lecturer on Chemistry, Technical School, Manchester;
Examiner in Chemistry, Blairlodge School, Polmont, N.B., &c.

My attention has been occupied with a chemical and microscopical study on the action of various compounds on the lower forms of plant life. I have already presented to the Chemical Society of London a paper on the action of a solution of ferrous sulphate on certain parasitic diseases which attack our crops. I wish here to detail some studies on the action of salicylic acid on certain ferments (organised and unorganised). A solution of salicylic acid was prepared containing 0·2 grm. of the acid in 1000 c.c. of water. A drop of yeast was placed on a slide under the microscope, and then a few drops of the above salicylic acid solution was run in between the slide and cover-slip, when I found that it had no action on the true alcoholic ferment; for I was unable to stain the protoplasm of the cells with a dilute solution of eosin, showing that the protoplasm was not dead. But when I operated in a like manner on certain other organised ferments,—viz., on Mycoderma aceti, Bacterium lactis, and the Butyric

* *Répert. de Pharm.*, vol. xli., No. 9, p. 406.

† A Paper read before the Royal Society of Edinburgh, Jan. 4, 1886.

bacillus—it was very different. On running in the same salicylic acid solution upon slides containing these various ferments they were quickly destroyed. What was observed under the highest powers of the microscope was that the salicylic acid acts chemically upon the cellulose or the *form* of cellulose making the external walls of these lowly organisms. It was evident that the acid dissolved the cellulose wall, and in some cases I could see that the cellulose wall had been perforated by the acid solution.

Beyond these facts, I have found that the above-named aqueous solution of salicylic acid also prevents the chemical action of hydration by means of the soluble zymases. If yeast is added to a solution of cane-sugar, and to this solution the salicylic acid solution is added, no decomposition, according to the following equation, takes place :—

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6.$$

That is, the salicylic acid has acted upon the soluble zymase which is secreted by the Torula cerevisiæ. Hence no fermentation takes place. I allowed the above to stand for two or three days at a temperature most suitable to engender alcoholic fermentation (about 80° F.), and then tested for glucose sugars by means of Fehling's solution without any result. I also tried the action of the salicylic acid solution upon a solution of starch which had previously been "inoculated" with a small quantity of saliva. After standing several days I could not find the smallest trace of glucose sugar. From this, salicylic acid acts upon the soluble ferment (ptyalin) contained in saliva, preventing the hydrating action upon the amyloses.

Then, again, I have found that the above solution of salicylic acid acts chemically upon the cellulose walls of *dead* torulæ, destroying them in a similar manner to the organised ferments already described at the commencement of this paper, but it (the acid) has *no* action on the *living* torula. This shows that a chemical change must have taken place in the molecular structure of the cellulose wall of the cell after death of the organism.

It is a well-known fact that in every brewery the yeast becomes deteriorated at certain times, and hence the beer brewed by such yeast is not so good as formerly. This is due to "disease ferments" in the yeast (the organisms I have alluded to in the early part of this paper). The common remedy is for the brewer to change his yeast. But I have found that this is not essential if the brewer waters the "diseased yeast" with the solution of salicylic acid; the "disease ferments" are all destroyed; the yeast is not acted upon by this solution. Yet at the same time the yeast so treated is not so active in its decomposition of a glucose solution into alcohol. This yeast can be revivified by an aqueous solution containing 0·25 grm. of potassium nitrate and 0·2 grm. of sodium phosphate in 2000 c.c. of water. In fact, the torula appears to decompose a much larger quantity of sugar (in wort) into alcohol in a given time after the above salts have been added to 2 litres of wort than when the wort is not so treated. It appears that the torula lives its life-history to a certain extent by extracting the potash and phosphoric acid from these mineral substances, which come into the wort from the barley and hops. Mitscherlich long ago showed that the ash of yeast gave no less than 53 to 59 per cent of phosphoric acid, and from 28 to 39 per cent of potash. Hence it may be that a larger amount of alcohol would be produced in beers by the addition of small quantities of the above substances to the wort.

From the above investigation the following conclusions are to be drawn :—

(1.) That a certain solution of salicylic acid has no action on the living torula, but dissolves it when dead, showing that some chemical change (post-mortem) has taken place in the cellulose of the cell-wall.

(2.) That the solution of salicylic acid destroys "disease ferments" by acting upon the cell-wall, showing that their cellulose most probably differs from the cellulose of the Torula cerevisiæ.

(3.) That the solution of salicylic acid prevents the hydrating action of the various soluble zymases.

(4.) A solution of sodium phosphate and potassium nitrate revivifies exhausted yeast, and even increases the yield of alcohol in saccharine solutions.

(5.) Salicylic acid acts as an antiseptic agent of great value, because it acts directly on the disease ferments in beers, and not upon the true alcoholic ferment.

(6.) Salicylic acid is not a poison in quantities far exceeding the amount in the solution given in this paper. The acid is largely used in medicine in both France and Germany.

For those interested in the application of this acid in medicine I refer them to the following memoirs :—

(*a*.) Wagner's, "Le traitement de la diphterie, des maladies de l'estomac et des intestins."—*Moniteur Scientifique*, 1875, p. 355; also *Journal fur Praktische Chemie*, xi., pp. 57 and 211.

(*b*.) Dr. Germain See's, "L'acide salicylique et les salicylates dans le traitement de la goutte et des rhumatismes."—Rapport à l'Académie de Mèdecine de Paris, June and July, 1877.

(*c*.) Fontheim's, "De l'action de l'acide salicylique employé comme médicament."—*Moniteur Scientifique*, 1875, p. 853.

ON A

METHOD OF ANALYSIS APPLICABLE TO MIXTURES OF HYDROCARBONS OF THE AROMATIC SERIES.

By C. FRIEDEL and J. M. CRAFTS.

There exist in the aromatic series four isomeric bodies answering to the formula C_8H_{10}: ethyl-benzene and the three xylenes. All four may originate in the decomposing action of aluminium chloride heated with hydrocarbons. The formation of ethylene in this reaction is not indicated by the escape of this gas, but by the presence of ethyl-benzine and ethyl-toluene among the products. Consequently, in the product boiling at 138°, we have to search for ethyl-benzine mixed with the xylenes.

The question is already solved for cases where toluene is heated to about 200° with aluminium chloride in a closed vessel. Under such circumstances there are obtained very considerable quantities of the ethylated benzines; but at a lower temperature the decomposition of the toluene is much less complete, and there is found only a small proportion of ethyl-benzine mixed with the xylenes, and to detect its presence a new analytical process is required. The best methods of separation hitherto employed are based upon Jacobsen's researches on the sulpho-conjugated acids. But this process, which works by means of fractionated crystallisation, is difficult to use for the analysis of a limited quantity of matter. The old methods for the oxidation of the hydrocarbons give characteristic products, but always with great losses of material, and as the hydrocarbons are unequally burnt by the oxidisers, we cannot judge of the relative proportion of the hydrocarbons contained in a mixture by the quantity of the acids obtained.

By the method which the authors propose the analysis may be made on a few decigrms. of material, but when ethyl-benzine is present it is preferable to employ a larger quantity, up to 5 grms.

Dry bromine mixed with 1 per cent of iodine converts the three xylenes exactly into tetra-bromides, whilst ethyl-benzine forms a dibromated substitution-product of more or less definite composition, but capable of being converted by the addition of bromine in presence of aluminium bromide or chloride into penta-bromated ethyl-benzine. This compounds melts at 141·5°: it crystallises in fine clinorhombic prisms, and distils with a considerable

decomposition at the ordinary atmospheric pressure, but at the pressure of 0·16 metre of mercury it can be distilled without decomposition. It is soluble in 11 parts of petroleum ether at 20°, and the bibromic product formed by the action of iodised bromine is miscible almost in any proportion with petroleum ether. The tetrabromised xylenes are much less soluble, requiring about 200 parts of petroleum ether. They are separated from ethyl-benzine as follows:—

To the mixture of hydrocarbons we add about ten times their weight of bromine containing 1 per cent of iodine, and the whole is allowed to stand for ten hours at the ordinary temperature. The excess of bromine is removed with a solution of potassa, the bromised product is dried and washed with petroleum ether in successive portions until the product extracted has a melting-point higher than 240°. The petroleum ether is evaporated to incipient crystallisation. We may even continue the evaporation as long as the tetrabromo-xylenes separated have an elevated melting-point. The small quantity of these bodies remaining in the liquid (the weight of which is ascertained) may be calculated from their solubility as given above.

The ethyl-benzine is then determined in a definite state of combination. After having evaporated the solution and driven off the petroleum ether, we mix the partially bromated product with 4 or 5 parts of bromine, which dissolves it without chemical action. On adding aluminium bromide or chloride hydrobromic acid is evolved. After some hours all the hydrogen of the central chain is replaced by bromine, whilst the ethyl-group remains intact. It is purified by a washing in potassa, crystallised out of benzine, and the ethylene pentabromide is weighed. A correction must be made for the small quantity of xylene tetrabromide which remains mixed with the ethyl-benzine. A determination of bromine serves to check the results, and to calculate the proportion of ethyl-benzine pentabromide in the substance weighed.—*Comptes Rendus*, ci., p. 1218.

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.*

By P. T. CLEVE.

The following is a *resumé* of my researches on the compounds of samarium. I had also intended to prepare and examine the metal, but the quantity of pure oxide of samarium at my disposal was not sufficient. On completing the separation of the oxides, which accompany the oxide of samarium, I expect to obtain a considerable additional quantity of the latter.

I have endeavoured to determine the specific gravities of the compounds of samarium, wherever the properties of the substances rendered an accurate determination possible. The determinations were all made in a perfectly uniform manner, viz., by weighing in benzol, care being taken in each case to determine the specific gravity of the benzol and of the substance at the same temperature. Every determination was carefully made, and I believe, therefore, that the accuracy of the results may be relied upon.

In the case, however, of certain anhydrous and very hygroscopic salts, obtained by heating the crystallised salts, great accuracy could not be attained.

In carrying out these researches I have been assisted by L. I. Eriksson, who made several of the analyses and some of the specific gravity determinations, for which I gladly take this opportunity of thanking him.

The crystalline forms of several of the salts of samarium have been determined by H. Sjögren, who will publish a more complete account of his researches later on.

* Presented to the Royal Society of Sciences of Upsala, Feb. 13, 1885.

In order to make this paper a complete monograph, I have included in it the most important facts contained in a paper on samarium published by me some time ago.*

History.

The first indications of the existence of samarium date back to the year 1878, when Delafontaine,† in examining impure didymia, extracted from samarskite, observed some new absorption-bands which he ascribed to a new metal, having an atomic weight of 106, assuming the oxide to have the formula RO, or 159 if R_2O_3 be the correct formula. He named the new metal decipium.

Some time later Lecoq de Boisbaudran‡ found also in samarskite an oxide, the solutions of which were characterised by a peculiar absorption and emission spectrum. He succeeded in separating this oxide from didymia by means of repeated fractional precipitations of the mixed nitrates by dilute ammonia. He called the metallic radical samarium. In 1880 Delafontaine§ published some researches on the compounds of decipium, the atomic weight of which he now found to be 114 or 171, according as the formula of the oxide be taken as DpO or Dp_2O_3. He found the sulphate to be much less soluble than the sulphate of didymium. The salts were colourless. Shortly after this Marignac‖ published a paper on the samarskite earths. By taking advantage of the different solubilities of the sulphates in a saturated solution of potassium sulphate he succeeded in separating two oxides, which he designated provisionally as Yα and Yβ. The atomic weight of the metallic radical of Yβ was 99·6 or 149·4, according to the formula assumed for the oxide.

The salts were yellow, and gave the absorption-spectrum first observed by Delafontaine, and more accurately described by Lecoq de Boisbaudran. The other oxide, Yα, obtained by Marignac, was white, and gave colourless salts having no absorption-spectrum. The sulphate formed with potassium sulphate a double salt soluble in a saturated solution of potassium sulphate, a quantity of this double salt corresponding to 1 grm. of the oxide dissolving in 100 to 150 c c. of the potassium sulphate solution. The corresponding double sulphate of Yβ was much less soluble, while that of the terbia was more soluble. The atomic weight of the metallic radical of Yα was estimated to be as a minimum 104·5 (or 156·75).

The identity of the absorption-bands leads to the conclusion that decipium, samarium, and Yβ all three contained the same element. But the atomic weights as determined by Delafontaine and by Marignac differed greatly.

Later on Delafontaine¶ admitted that his original decipia could be split up into two different oxides, one with an absorption-spectrum and one without. For the element in the former he adopts the name samarium, reserving the name decipium for the element in the latter. The respective atomic weights were 101 (or 151·5) and 111·3 (or 167). The Yα of Marignac he regards as a mixture of terbia and decipia, but as terbia is orange-coloured and Yα almost white this supposition seems to be inadmissible.

Separation.

There is no complete method of separating samaria from the other earths which accompany it. In order to remove the yttria earths advantage may be taken of the sparing solubility of the double sulphate of samarium and potassium in a saturated solution of potassium sulphate; but the most convenient method of separation from didymia is by fractional precipitations of dilute solutions of the nitrates by very dilute and cold ammonia. Samaria is precipitated first, but the operations must be repeated a

* *Journal of the Chemical Society*, ccxlix., Aug., 1883. *Öfversigt af K. Sv. Vet. Akak. Förhandl.*, 1883, No. 7, p. 17.
† *Comptes Rendus*, lxxxvii., 632.
‡ *Ibid.*, lxxxviii., 322, and lxxxix., 212.
§ *Arch. des Sc. Phys et Nat.*, [3], iii., 250.
‖ *Ibid.*, [3], iii., 413.
¶ *Comptes Rendus*, xciii., 63.

great number of times. In order to obtain a pure oxide it is necessary to combine both methods. The sulphate of samarium is much less soluble than the sulphate of didymium, but as these salts are isomorphous no good separation can be founded upon this difference.

Mode of Occurrence.

Samarium has been found in samarskite, in gadolinite, in orthite, and in cerite, but there can be no doubt that this element will be found together with didymium in all minerals containing the latter metal. Nevertheless didymium seems always to occur in greater quantity.

Atomic Weight.

In my paper on samarium, which appeared in 1883, I published determinations of the atomic weight of samarium. By combining known quantities of samaria with sulphuric acid I obtained as a mean of six experiments the number 150·02 (maximum 150·12, minimum 149·94), assuming for the oxide the formula Sm_2O_3. This number agrees as well as could be desired with Marignac's determination of the atomic weight of $Y\beta$, viz., 149·4.

Spectrum of Samarium.

The chloride of samarium gives a spark-spectrum, composed of a great number of lines, for the most part of little intensity. They have been very carefully mapped by Professor Thalén,* who has registered 198 lines of samarium. A great number of them were formerly attributed to didymium. Many of the samarium lines were also observed by Roscoe and Schuster,† and by them attributed to terbium.

The absorption-spectrum of samarium has been described by Lecoq de Boisbaudran, by Soret,‡ and by Thalén. Their descriptions agree perfectly, and according to them the wave-lengths of the bands are:—

559—556	.. ..	yellow
497—500	.. ..	,,
486—472	(strong)	blue
466—460	(strong)	,,
445—437	(weak)	,,
419—415	.. ..	violet
409—401	(very intense)	,,

There are also, according to Soret, several absorption-bands in the ultra-violet part of the spectrum, the wave-lengths or which are—

375—373
364—360
344

Becquerel§ also discovered in the infra-red some absorption-bands with wave-lengths 1145 and 1040.

(To be continued).

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 17, 1885.

Prof. W. C. WILLIAMSON, LL.D., F.R.S., President, in the chair.

"*On Some Recent Observations in Micro-Biology, and their bearing on the Evolution of Disease and the Sewage Question*," by F. J. FARADAY, F.L.S.

Nearly three years ago, in a letter which appeared in the *Manchester Guardian* of February 14, 1883, as a contribution to a controversy on the work of Pasteur and Koch, I concluded as follows:—"Pasteur is attenuating deadly parasites; before long some of his followers will evolve specific parasites from harmless saprophytes, and in the work of artificially evolving, some at least of the species, such gases as carbonic acid will render powerful assistance."

Replying to this letter, in the same journal, a London medical man spoke of the prediction as without foundation. I was the more surprised by such an expression of opinion from London, as the *Times*, commenting a few months previously on a paper on Koch's tubercle bacillus which I had read before the Biological Section of the British Association at Southampton, had been good enough to say that I had shown that empirical medicine had a scientific basis. In that paper I had argued that deprivation of free oxygen, or cultivation in gaseous mixtures from which the normal supply of free oxygen present in fresh air is absent, probably had an influence in converting otherwise harmless organisms into the parasitic bacilli of tuberculosis. I had submitted that the lungs of persons of hereditarily narrow-chested structure, or of weak breathing habit, or of persons spending much time in a vitiated atmosphere, engaged in dusty occupations, or suffering from bronchial catarrh, presented the requisite conditions of culture, assuming the presence of the germs of organisms which might otherwise discharge a useful function in the chemistry of life, possibly even in the chemical function of the lungs themselves. Dr. Angus Smith had also pointed out (*Rivers Pollution Report*, 1882) that the putrefying process, when carried on in open rivers, such as the Clyde, does not seem to produce any marked form of disease; whereas the gases escaping from covered sewers are apparently associated with specific zymotic maladies; and he had suggested that "we require to learn whether any of the germs of disease, or which germs, will live in an abundance of good air." Dr. Smith had hinted that possibly the relative harmlessness of putrefaction in open rivers was a consequence of the less concentration of the resultant gases, or the more thorough putrefaction, oxidation, and destruction of the organic substances. Looking at the question from the biological rather than from the chemical standpoint, it seemed to me that with all these ideas floating about, and especially after the discovery of Koch's tubercle bacillus, there was considerable foundation for the suggestion that possibly certain gases might have an influence in converting micro-saprophytes into micro-parasites, and it did not seem a long step from this primary thought to the idea that carbonic acid might be such a gas.

As the carbonic acid idea was, therefore, in the words of Touchstone, "all ill-favoured thing, but mine own," I may be permitted now to direct attention to a footnote appended to M. Pasteur's paper on a method of preventing hydrophobia after infection, read before the Paris Académie des Sciences on the 26th ult. M. Pasteur describes his method of attenuating the virus present in the marrow of rabbits which have died of rabies, by suspending portions of the marrow a few centimètres in length in dry air, the degree of attenuation being directly proportionate to the time of exposure, the dimensions of the fragment, and the temperature, the rabid property of the marrow being ultimately extinguished. The lower the temperature the more slow is the process of attenuation. By this process a graduated series of infective material, suitable for prophylactic inoculations, is obtained. M. Pasteur then says—"If the rabid marrow be kept from contact with the air, in carbonic acid gas, in a moist state, the virulence is maintained undiminished (at least for several months), provided that it is protected from foreign microbic alteration."

M. Pasteur has not yet discovered any microbe as peculiar to rabies, though the fact that a perfectly definite period is required for the development of the disease when the virus is introduced directly to the nerve centres,

* *Öfversigt af K. Sv. Vet. Akad. Förh.*, 1883, No. 7, 3.
† *Journ. Chem. Soc.*, xli., 1882, 283.
‡ *Arch. de Sc. Phys. et Nat.*, [3], iv., 261.
§ *Ann. de Chim. et de Phys.*, [5], xxx. 5.

which appear to constitute its appropriate *nidus*, is suggestive of the existence or evolution of a specific microbe. It is also as yet a mystery as to how, in the case of an ordinary bite, the affection is conveyed to the nerve centres, whether, by transmission through the blood, the specific infection ultimately obtains a lodgment in the ganglia suitable for its incubation, or whether an influence is conveyed through the nerves which sets up corresponding changes in Béchamp's hypothetical micro-zymes in the nerve centres, thus evolving from healthy material morbid organisms whose action is identical with that of the disturbing causes.

In this latter supposition we seem to see something analogous to induced electricity, and I may add that, throughout the whole of the phenomena of zymotic disease, there is a suggestion of action with corresponding and intensifying reaction. Given a micro-organism producing a certain effect upon an environment, that effect, in the absence of disturbing influences, seems to react upon the organism itself and increase its ability to reproduce the specific effect. To make my meaning clearer, let us suppose microbia present in a confined sewer. Their action results in the production of certain gases, and the presence of those gases again intensifies the action of the microbia. Or, to put another supposition, certain microbia present, say, in the peripheral regions of the nervous system, produce a given effect through the nerves upon the nerve centres, and that effect re-developes, from the "organic molecules" of the nerve centres, organisms or ferments capable of acting precisely as the original microbia acted. Such suppositions appear to offer explanations of the varying virulence of zymotic diseases, and of the discoveries by Pasteur and his disciples relating to the attenuation or intensifying of microbia. They may also provide the key to the mystery of protective inoculations. For the mild vaccine calls into existence a certain resisting power which appears to be intensified by the consequences of its own action.

Leaving such speculations on one side, however, for the present, what I wish now to point out is that in Pasteur's latest experiments we appear to have another illustration of the hygienic value of fresh air, and a confirmation of the suggestion that carbonic acid is a gas capable of at least preserving zymotic disease. May we not, hypothetically, generalise the idea, and carry it a little further, by saying not only that fresh air favours saprophytic life, while foul gases favour parasitic life, but that foul gases evolve parasitic from saprophytic life. It is a remarkable fact that no genuine pathogenic microbia have ever been obtained from collections made from the atmosphere. Dr. Miquel has made a vast number of experiments in the cultivation of atmospheric germs, only to arrive at the conclusion that pathogenic microbia "appear to be banished from the air." I venture to submit, however, that this does not imply that infection may not be communicated through the atmosphere. Attention has been called to the fact that epidemics often appear to follow heavy rains, and it has been suggested that the pathogenic microbia may be present in overflows of stagnant water, or may be washed into pools of water temporarily formed, so that, when these dry up, the germs are blown with the sediment into the atmosphere and inhaled, or deposited in milk or other beverages. As such conditions imply, however, not only the presence of abundance of fresh air, but also sunlight (to the hygienic action of which latter I am about to refer), the supposition is rather against the results of the experiments under consideration. If, however, we assume the presence of pathogenic germs in the foul atmosphere of ill-ventilated sewers, then heavy rains, or any other condition which diminishes the air space in the sewers, will force out more or less dense volumes, or gusts, of sewer gas, and the germs be conveyed directly to their new medium of culture, whether in the bodies of men or animals breathing such gases, or in the beverage which they infect; and they will be protected during their passage from the attenuating influence of fresh air by the appropriate environment which transports them.

We come now to the influence of light and darkness on micro organisms, concerning which the results of some very interesting experiments, carried on independently by M. Duclaux and M. Arloing, have lately been made known. I proceed to consider these with the more pleasure, as they afford me an opportunity of again referring to one of those suggestive and thoughtful utterances which abound in the writings of our late revered member, Dr. Angus Smith. Referring to the fact that fevers have not been traced to open rivers, or to putrefaction in the open air, though they have been traced to decomposition taking place under cover, as in sewers, Dr. Smith observes, in a paper published in 1880, "The question arises, Is this owing to the concentration, or to the difference of decomposition in darkness, or to the better supply of oxygen? The effect of sunlight in warm countries does not allow us to suppose that the daylight always produces in vapours an innocent state, although it has a great effect in that direction when there is little water." M. Duclaux evaporated cultures of microbia in tubes, and then preserved the dried spores, carefully protected from external contamination, some being sheltered from the sunlight, and others being exposed to it, for various periods. The temperature of the sheltered tubes was regulated in all cases so as to be approximate to the maximum heat obtained from the sun by the exposed tubes, so that, excepting the light rays, the conditions in all cases were equal. On suitable infusions for culture being subsequently added, M. Duclaux found that the sheltered spores developed much more readily and abundantly than the exposed spores; the sunlit tubes proved, in fact, more or less sterile, according to the time of exposure, those which were exposed for the longest time entirely failing to give any evidence of microbe life. The fermentive action of the specific microbe experimented with, *Tyrothrix scaber*, is analogous to that of pathogenic microbia, as it destroys albumenoid matter; though it is important to bear in mind that it is what M. Pasteur calls an acrobic species. The dried spores of this microbe, when protected from the direct light rays of the sun, resisted the action of free air and a tropical temperature for three years, and germinated at the end of that period. A month's exposure to the sunlight, however, diminished the germinating power of the spores, and after two months' exposure 50 per cent of the tubes proved sterile. Similar experiments were tried with pathogenic micrococci. Cultures in broth preserved their vitality for at least twelve months, if sheltered from the direct rays of the sun. Exposure for forty days to the feeble and intermittent rays of the spring killed them; a fortnight's exposure to the July sun killed them; and exposure for a less number of days attenuated them, and deprived them of all power over the animals most susceptible to their influence. M. Arloing experimented with the anthrax bacillus, and found that sunlight diminished the vegetative power of the mycelium. Two hours' exposure to a July sun was sufficient to make a freshly infected broth sterile. Exposure for less than two hours retarded the vegetative power. When the spores are in process of actual development, however, the sunlight does not stop the growth; the mycelium grows and produces spores, the filaments break up, and the spores are set free. The process is, however, slower, and in this respect is analogous to the development as it takes place when the organism is cultivated in infusions which are little favourable to its growth. Sunlight, in fact, produces results analogous to those of culture in an unfavourable environment. When the mycelium has already developed spores in a darkened stove, exposure to sunlight for thirty hours stops vegetation. The power of growth is gradually weakened by exposure to sunlight, before it disappears altogether. If a drop of a solarised culture is used as seed for a fresh infusion, the vigour of the second generation is diminished in direct proportion to the length of time during which the parent culture has

been exposed to the solarising influence; the process of development is more and more protracted. Again, the diminution of vigour continues through successive generations. A third generation, the two preceding parent cultures of which have been exposed to the solarising influence, if itself exposed to sunlight, loses its vegetative power more rapidly than either of the two preceding generations; the attenuative effect is, in fact, accumulated. These phenomena are accompanied by an attenuation of virulence if the successive cultures are inoculated in animals, and eventually the organism actually becomes its own vaccine. In proportion to the duration of the solarising influence and its continuance through successive generations, a larger and larger quantity of the virus is necessary in order to successfully inoculate guinea-pigs with the specific disease, and the progress of the disease in the animal becomes slower and slower, until at length the influence is protective against the consequences of inoculation with an unsolarised or virulent culture.

It has been pointed out by a French writer that these experiments again confirm the doctrine enunciated by M. Paul Bert, that any influence which arrests the development of a virus converts it into a vaccine. In the paper on "Pasteur and the Germ Theory," which I read before the Society last year, I argued that the difference between a harmless saprophyte and a deadly parasite was a difference of vigour. If I may formulate the idea again, I would say that a saprophyte is an organism which is able to utilise for its own life the residual forces in matter in which the specific or co-ordinating vital force has been extinguished; while the parasite is an organism which, in consequence of a given process of culture, is enabled to overcome the still existing specific vital force of the living organism on which it preys, and to divert that force to its own development. In some mysterious way light and oxygen are favourable to the vigour of the higher organism, and inimical to the vigour of the lower organism. These conditions determine which of the two is to be the subordinate. I have been led to think that the life-history of microbia is analogous to the earliest stages of the life-history of the higher organisms in this respect, and I am arranging some experiments in order to test this idea, the results of which I hope to communicate to the Society in due time. The higher plants and animals begin their lives in darkness, and as they grow attain to light and fresh air; and then, if I may so express it, the higher life is progressively evolved.

It is well to point out distinctly that, as yet, however much reason there may be for believing that pathogenic microbia are really evolved from originally harmless ferments which have a great utility in the economy of the universe, and whose subordinate action may even be absolutely necessary for the existence of higher forms of life, such evolution has not yet been experimentally proved. Conversely, however, we have meanwhile definite evidence that fresh air and sunlight attenuate the virulence of pathogenic microbia. Even this partial knowledge is of great practical importance. It cannot be overlooked that vitiated air and darkness generally go together, and that, on the other hand, fresh air and sunlight are usually coexistent. Both the first-named conditions are necessarily associated in the covered sewer. Whether the covered sewer does or does not actually evolve the disease is at present a matter of speculation; but that the peculiar conditions of the covered sewer nurture and strengthen the diisease may be regarded as experimentally proved. Now I find that in connection with the Ship Canal project it is proposed to construct a covered sewer to receive all the sewage of this city. Of the conditions to be provided in this culvert we have as yet only the vaguest intimations. I confess that I, for one, look forward with the greatest anxiety to the prospect of such a huge drain, in which so vast a mass of organic matter will be allowed to putrefy in darkness and in the midst of an environment of foul gases. It seems to me that this Society will only be true to the traditions of its early history, and discharge a duty to the city to which it pertains, by watching this culvert scheme closely, and asking what provision is to be made for continuing the hygienic influences at present exercised on the Irwell by free oxygen and sunlight (so far as we possess either one or the other in this district), or what precautions are to be taken to counteract the vicious consequences of the absence of both?

The philosopher sees the same principles throughout nature; he learns to recognise that simplicity and harmony are the essential features of the constitution of the universe. The principles of one science reappear in all the others; the study of any branch of natural philosophy results in generalisations which elucidate the phenomena of other branches. And if he turns from the physical side of nature to its moral side the thinker finds the lessons of the one applicable to the other, and confirmed by its phenomena. The recognition of this truth does not seem to me to be beyond the scope of science. Microbia have a beneficent function; Pasteur's pupil, Duclaux, has shown us that the seeds of the higher plants will apparently not germinate if microbia are excluded from the soil; and Pasteur himself has suggested that probably no young animal would live if its food were absolutely deprived of organised ferments. The evidence tends to show us that if these same ferments are compelled to live in the environment provided by their individual action alone, they become the agents of deadly disease. If we turn to the other extreme of the biological chain we find that, with his physical nature deprived of sunlight and fresh air, and his mental nature compelled to feed upon its own vagaries, in short, with his mind darkened and unaërated, man himself becomes morbid and mischievous.

"*On the Flow of Gases.*" By Professor OSBORNE REYNOLDS, LL.D., F.R.S.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

Ordinary Meeting, November 9, 1885.

Dr. ALCOCK, President of the Section, in the Chair.

Mr. ALFRED BROTHERS, F.R.A.S., read the following note on "*Microscopic Writing.*"

The Lord's Prayer has always been a favourite subject for testing the powers of minute caligraphy. To write the 227 letters within the space covered by the smallest coin is a feat of some difficulty, but that the same number of letters can be engraved on glass within a space so minute as to be almost invisible with the lowest power of the microscope, and the individual letters not defined clearly with an eighth object glass, may seem incredible. There is, however, in the possession of this Section a slide which contains the Lord's Prayer, written by W. Webb in 1863, within the space of the 405,000th part of an inch.

To find this minute speck requires the exercise of much patience, as it is not only necessary to have just the right kind of illumination, but the focus of the lens must be on the true surface of the glass on which the object is written. When once seen with a low power it is not difficult to find with the same power; but with the ⅛ inch and higher powers it is always a trial of patience even when the position of the object has been carefully registered with a lower power, and you are sure that the object is central in the field. Perhaps with the achromatic condenser some of the difficulty may be removed.

It will be remembered that about twenty years ago the late Mr. Rideout presented to the Section a machine for producing minute writing. The instrument was lent by Mr. Rideout to Mr. Dancer, by whom it was recently sent to the Society. It seemed to me that as this instrument was purchased by Mr. Rideout at the great Exhibition in 1862, it might be the same with which the wonderful piece of witing, or perhaps it should be called engraving,

referred to was executed. I therefore wrote to Mr. Dancer for information on this point. In reply he says:—"The microscopic writing on glass of the Lord's Prayer referred to in your letter was at one time in my possession, and was, I believe, presented by me to the Microscopical Section. It was obtained from Mr. Webb, and he was the same person who exhibited the microscopic writing machine at the great Exhibition of 1862. Mr. Webb died about ten or fifteen years ago, but I cannot give the exact date. I have a very strong impression that Mr. Rideout obtained the machine from him, which was sent by me to the Society. If able to find Mr. Rideout's letter it may confirm this." I have not received the letter, but as what Mr. Dancer says confirms the impression I have of what passed at the time, there can be little doubt that the instrument is the one used to produce the writing referred to.

Under the microscopes I have arranged two other slides of minute writing which have been lent to me by Mr. Armstrong. These are not *very* minute when compared with the one first referred to, and which I have placed under the third microscope where you will see the object with an eighth object glass. Even with this great amplification the words can scarcely be read, but it can be seen that only greater power is required to make the whole legible. It happens that the covering glass is very thick, so that powers higher than the eighth cannot be used. It will be noticed that the name *W. Webb*, 1863, is distinctly legible and very beautifully written.

Mr. Armstrong has given me some particulars of Webb's minute writing, from which it appears he was accustomed to write the Lord's Prayer in spaces of the 500th to the 10,000th of an inch, and, as we have seen, to the 405,000th, and the prices of these slides varied from 2s. 6d. to 70s.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I should feel much obliged if your correspondent "J. W.," who says that no notice was taken of his letter, would forward to me the date of his application, that I may enquire into the matter.—I am, &c.,

The Secretary of the Institute of Chemistry.

9, Adelphi Terrace, Strand, W.C.,
January 9, 1886.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—A meeting of the members of the Institute of Chemistry who reside in Manchester and district was held last night at the rooms of the Chemical Club of Manchester, with a view of considering the very important questions in reference to the Institute which are at present being discussed in your journal, and with the intention of taking some combined action if considered advisable, so that the views of the majority of the members in the North of England, and generally perhaps in the provinces and in London, may be brought before the Council for its consideration.

The following resolutions were passed, and I was requested to forward them to you for publication:—

1. That this meeting deems it advisable that properly qualified chemists of good standing should at the present time be admitted to the Fellowship of the Institute without undergoing examination.
2. That new members so entering be not admitted on the same terms as the old members, but that some such difference be made as the following, viz.: —That the new members pay an entrance fee of, say, 5 guineas, and that they pay, say, 2 guineas subscription for the first five years, and afterwards that they pay a subscription of one guinea per annum. *The subscriptions of the whole of the present members being reduced to one guinea per annum from the beginning of this year;* and that the old members be at liberty, by the payment of, say, five or ten guineas, to purchase Life Fellowships.
3. That this meeting considers it desirable that the existing regulation of the Council, to the effect that a candidate for the Associateship must have studied three years in one of a limited number of specified colleges, should be extended, so as to allow such candidate to present himself for examination provided he has studied and practised for at least three years in the laboratory of a Fellow of the Institute in actual practice.
4. That the following members of the Institute, with power to add to their number, be constituted a Committee *pro tem.* to promote the acceptance of the resolutions passed at this meeting:—

John Angell.	Ferdinand Harter, Ph.D.
J. Carter Bell.	David Watson, D.Sc.
W. H. Darling.	Percy James Winser.
Charles Escourt.	

5. It was further resolved to request all the members of the Institute who are favourable to the views expressed at this meeting, or to any slight modifications of them, to communicate at once with me, that their names and any suggestions they have to make may be communicated to the next meeting of this committee.

—I am, &c.,

William Thomson,
Hon. Sec. pro tem.

Royal Institution Laboratory,
Manchester.

SCIENCE IN THE LAW-COURTS.

To the Editor of the Chemical News.

Sir,—The catechetical form of instruction—question and answer—is now justly scouted by educators and abandoned in our manuals and text-books. It is therefore very strange that the *Journal of Gas-Lighting* should consider the establishment where it still flourishes as "the supreme temple of arts and sciences" and the "greatest teaching university of the world."

Surely judge, jury, and spectators would more clearly understand expert evidence if read to them in the form of a continuous report, duly prepared beforehand, and where none of the "unwarranted assumptions, blunders, and slips of memory" which your contemporary mentions could have place. Such a report, drawn up by two or three disinterested men of science, and accepted as is the ruling of the judge on a point of law, would be much more satisfactory than our present system.—I am, &c.,

Experto Crede.

SCIENCE IN THE LAW-COURTS.

To the Editor of the Chemical News.

Sir,—Your view on the necessity for a reform in this subject is shared by Dr. C. G. Garrison, who, writing in the *Medical Bulletin*, contends that "as expert, the position of the physician is judicial, and he should be called by the Court, not by the litigants." By a parity of reasoning the same rule must apply to the chemist and the physicist, if their evidence is required as experts.

The *Medical Press and Circular* also supports the proposal of scientific assessors in Courts of Law.—I am, &c.,

R. B.

COMMERCIAL ANALYSES.

To the Editor of the Chemical News.

Sir,—Complaints have appeared from time to time in the columns of the Chemical News of discrepancies between the results of different chemists to whom samples of some commercial product had been submitted for examination. With your permission I should like to direct attention to the serious differences in determinations of oxide of iron and alumina which almost always occur when samples of phosphate are sent to two or more chemists for analysis. The following table records the experience recently obtained by a house of business with which the writer is connected. To avoid mentioning names I describe each chemist by a number, and may add that all are well-known members of the profession practising in London.

	I.	II.	III.	IV.	V.	VI.	VII.
Carolina Land—							
P_2O_5 = tribasic phosphate	58·42	58·25	57·68	—	—	—	—
Oxide of iron and alumina	3·30	6·06	4·34	—	—	—	—
Belgian—							
P_2O_5 = tribasic phosphate	—	—	49·60	49·34	—	50·06	—
Oxide of iron and alumina	—	—	7·14	4·47	—	4·03	—
Belgian—							
P_2O_5 = tribasic phosphate	—	—	46·06	—	46·50	—	—
Oxide of iron and alumina	—	—	14·57	—	10·30	—	—
Aruba—							
P_2O_5 = tribasic phosphate	—	—	76·30	—	—	—	79·02
Oxide of iron and alumina	—	—	4·28	—	—	—	3·50
Aruba—							
P_2O_5 = tribasic phosphate	—	—	77·64	—	—	—	79·31
Oxide of iron and alumina	—	—	5·52	—	—	—	3·75

In these cases the uniformity of the samples was beyond all question—they were in fact absolutely identical—and I can only explain the matter by supposing that the various chemists employ different methods of analysis. Can any of your readers offer suggestions which might lead to more concordant results being obtained? By so doing they will be conferring a great boon upon merchants and manufacturers, to whom these discrepancies are a continual source of annoyance and vexation.—I am, &c.,

X. Y. Z.

TURNIPS WITHOUT SULPHUR.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. liii., p. 289, Mr. Thomas Jamieson reports that turnips grew well in soil containing no sulphur, and that "fully developed turnips gave on analysis no sulphur whatever."

I would like to inquire what they tasted like, and what would be the probable taste of mustard or horseradish thus grown? And also to ask if fertile seeds of such Cruciferæ as mustard, turnip, cabbage (all *Brassica*) have been obtained free from sulphur, or if Mr. Jamieson supposes that they can be?—I am, &c.,

S. A. N.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ci., No. 25, December 21, 1885.

This issue contains merely the account of the Annual Public Session held on Dec. 21, and the awards of the prizes which are in the gift of the Academy. The Bordin prize was assigned to M. Edlund for his reply to the question: "to find the origin of atmospheric electricity and the causes of the great development of electric phenomena in storm-clouds." The Jecker prize in chemistry has been divided between MM. Prunier, Silva, and G. Rousseau. The Lacaze prize in chemistry has been awarded to M. A. Ditte, of Rouen. The "grand prix" in the mathematical sciences proposed for 1886 is:—"to improve in some important point the theory of the application of electricity to the transmission of work."

No. 26, December 28, 1885.

Application of the Numerical Laws of Chemical Equilibria to the Dissociation of Chloral Hydrate.—H. Le Chatelier.—A mathematical paper not susceptible of useful abridgment.

Action of some Reducing Agents upon Vanadic Acid.—A. Ditte.—The author examines the action of hydrogen, sulphur, ammonium oxalate, arsenic, phosphorus, and sulphurous acid upon vanadic acid. By their means he obtains the following series of oxides, V_2O_9, V_2O_8, V_2O_7, and V_2O_6.

The Preparation and the Physical Properties of Phosphorus Pentafluoride.—H. Moissan.—The author maintains that the pentafluoride cannot be obtained in a state of purity by Thorpe's process. He prefers to pass an excess of gaseous phosphorus trifluoride into bromine at −15°. The result is a liquid phosphorus pentafluobromide which slowly decomposes, yielding solid phosphorus pentabromide and gaseous pentafluoride. This is an incombustible gas, of a pungent odour, fuming strongly in the air, and entirely soluble in water. Its density in three experiments was found to be 4·50, 4·49, and 4·48. At 16° and under a pressure of 46 atmospheres it becomes liquefied. At this temperature the liquid has no action upon silicates. If gently released from pressure there is formed in the tube a snow-like solid which quickly melts.

Combinations of Gold Trichloride with Sulphur and Selenium Tetrachlorides.—L. Lindet.—The double gold and sulphur perchloride forms fine yellow needles. It loses chlorine even at common temperatures, even if an attempt is made to dry it in a current of chlorine. It is hygroscopic and is decomposed by water, yielding brown liquids not yet studied. Gradually the gold is reduced and all the sulphur passes into the state of sulphuric acid. The corresponding selenium compound forms tabular crystals of a fine red, slightly inclining to orange. The author has not succeeded in combining gold chloride with other acid chlorides.

Thermic Researches on Glyoxylic Acid.—M. de Forcrand.—Not susceptible of useful abstraction.

The Oxidation of Sebacic Acid.—H. Carette.—The oxidation of sebacic acid yields almost exclusively succinic and adipic acids and normal propylene dicarbonic acid.

A New Means of Verifying the Purity of Volatile Bodies.—E. Duclaux.—The author utilises the proces

of fractional distillation proposed in his thesis. On distilling a known volume of the solution of an alcohol or a volatile fatty acid, of which equal portions are collected, the quantities of alcohol or of acid contained in each of these portions goes on increasing or decreasing according to a regular law, characteristic of the body examined, and such that this body is so much the more easily volatile in a dilute solution as it is less pure.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiv., Part 8.

The Part of Winds in Agriculture, with Especial Reference to the Fertility of the Limagne in Auvergne—Noticed under *Comptes Rendus*, vol. c.

Nature of a Sediment found in an Impure Well.—From the *Comptes Rendus*, vol. xcviii.

Moisture of the Soil in Pure Plantations of Scotch Fir and in those with an Undergrowth of Beeches, &c.—Dr. E. Ramann.—In the latter the proportion of water in the upper strata of the soil is greater than in the former.

Purification of Sewage by Filtration through Peat.—Alex. Müller.—The filtrate, without dilution, is carried beyond the stage of offensive putrefaction.

The Continuous Cultivation of Wheat on the Experimental Field at Rothamsted.—B. Lawes and H. Gilbert.—From the *Journal of the Royal Agricultural Society of England.*

Production of Fat in Cattle.—Prof. W. Henneburg.—The poverty of a food in fatty matter does not interfere with its efficiency in the production of fats.

Influence of Bile, its Acids and Salts upon Saccharification and the Formation of Peptone.—H. Chittenden and W. Cummins.—Already noticed.

Conveyance of Nutrient Matter from the Intestine into the Lymphatic Vessels.—E. A. Schæfer.—From the *Proceedings of the Royal Society.*

Contribution to the Knowledge of Milk.—Prof. W. Fleischmann.—An examination of the accuracy of the constants in the author's formulæ for calculating the total solids of milk from its sp. gr. and from the percentage of fat.

Comparative Experiments with Earth-nut Cake and Rye-meal on Milking Cows.—F. Meyer.—Ground earth-nut cake gave a better result than rye-meal.

The Value of Different Feeding Beets.—Prof. A. Meyer.—The kind known as "Golden Tankard" yields per acre nearly double the amount of nutritive matter as compared with Mammoth and Oberndorfer.

Experiments on Feeding Sheep with Sugar.—Prof. W. Henneberg.—It appears that the consumption of 100 lbs. sugar increased the living weight of the animals by the value of $31\frac{5}{100}$s.

Relations between Harvest-Time and Climatic Relations.—Prof. H. Karsten.—In the season of active vegetation there are two maximum periods of rain-fall, viz., the last week of June and the first week of July, and again from the middle of August to the middle of September. If, therefore, hay can be secured before June 24th the prospects of a good crop are favourable. The mean harvest time for barley, peas, wheat, and oats falls in North Germany prior to the beginning of the second rainy period.

Chemical and Physiological Action of Light upon Chlorophyll.—Timiriazeff.—From the *Comptes Rendus.*

On Glykogen in Plants.—Leo Errera.—The author shows that starch and glykogen are isomers or polymers.

Mineral Matters in the Seeds of the chief Forest Trees.—R. Hornberger.—The fruit of the elm gave the largest proportion of mineral matter, then follow the plane, pine, fir, ash, birch, beech, and oak, and lastly the alder and the larch.

Chemical Composition of the Banana.—L. Ricciardi.—The green banana contains one-eighth of its weight of starch. In the ripe fruits this disappears along with the tannin and the organic acids.

Digestibility of Different Kinds of Cheese.—Dr. von Klenze.—The complete digestion of cheese depends principally on its ripeness and only secondarily on its quality.

Journal de Pharmacie et de Chemie.
Series 5, Vol. xii., No. 11, December 1, 1885.

Action of Arsenic, Lead and Zinc on the Vegetable Organism.—MM. Nobbe, Baesler and Will. Already noticed.

Paratoluidine Sulphate as a Reagent for Nitric Acid.—From the *Moniteur Scientifique.*

Researches on Factitious "Fruit Essences."—MM Poincaré and Vallois.—All these substances produce in dogs, guinea-pigs, &c., various grave symptoms, but no danger seems to be apprehended from their ingestion in minute doses.

Apparatus for the Determination of Oxygenated Water.—M. Maurice de Thierry.—This memoir requires the accompanying figure.

No. 12, December 15, 1885.

Assay of Essences. Value of Classical Methods.—P. Carles.—The method with fatty oils is not trustworthy. The water and the calcium chloride methods detect falsification with alcohol even in minute quantities.

Digestion of Fatty Bodies.—E. Bourquelot.—A physiological paper.

Paralysis by Neuritis following upon Subcutaneous Injections of Ether.—M. Arnozan.—This paper offers no chemical interest.

Characteristics of Blood in Urine.—A. Luchini.—From the *American Journal of Pharmacy.*

Determination of Uric Acid.—E. Ludwig.—From 100 to 200 c.c. of urine is treated with magnesia mixture and an ammoniacal solution of silver nitrate. The uric acid is precipitated as a magnesium and silver salt, and the phosphoric acid as a magnesium and ammonium phosphate. The precipitate is collected on a filter, washed with ammonia-water, and heated with a solution of an alkaline monosulphide which converts the uric acid into a very soluble alkaline urate. The whole is filtered, the filtrate is acidified with hydrochloric acid, and reduced to a small bulk by evaporation, when the uric acid is thrown down in crystals. These are collected on a filter, washed with water, dried, washed with carbon disulphide to remove traces of sulphnr, dried, and weighed (*Archiv der Pharmacie*).

The Caseine of Milk and the Action of Rennet.—M. Eugling.—From the *Journal of the Chemical Society* and *Land. Versuchs-station.*

Detection of Potato Spirit.—M. Hager.—The reagent is a solution of 1 part mercury nitrate in 9 parts of water. It is acidulated with a trace of nitric acid and allowed to stand over metallic mercury until it is clear. If to 3 c.c. of absolute alcohol or wine alcohol at 90 per cent 3 drops of the test-liquid are added and the mixture shaken up, it becomes milky, takes a yellowish white tint, and after standing for some hours it leaves a pale yellow deposit at the bottom of the bottle. Corn spirit gives the same result if free from acetic ether or similar ethers. With potato spirit the mixture takes a bluish white tint, and the precipitate formed in nine to twelve hours is only about one.

third of the bulk of that given by pure spirit, and is white, whilst the supernatant liquid has a bluish opalescence.

Journal für Praktische Chemie.
New Series, Vol. xxxii., Parts 6, 7, 8, and 9.

Researches from the Chemical Laboratory of the University of Leipzig.—These consist of memoirs by H. Schœne, on chloro-carbonyl sulphamyl and its action upon nitrogenous compounds; by M. Seidel, on the action of chloro-carbonic acid upon phenyl- and diphenyl-sulphurea; and by Fr. Gumpert, on the knowledge of phenyl-isocyanate.

Electro-Chemical Studies.—W. Ostwald.—In this third treatise the author discusses the influence of the composition and constitution of acids upon their electric conductivity. The memoir is exceedingly voluminous, and is incapable of useful abstraction.

Ultramarine Blue in the Moist Way.—Fr. Knapp.—The blue colour ordinarily produced by roasting the "ultramarine-mother" (the mass obtained by the preliminary ignition of china-clay, soda, and sulphur) can also be produced in the moist way. For this purpose the aluminium silicate must be heated to a certain degree with sodium carbonate and sulphur, and the product of the ignition must then be digested for some time with a solution of sodium sulphide. If kaolin or any analogous silicate is treated at once, without ignition, with a solution of sodium sulphide, no blue colonr is produced, even after digestion for months.

The Behaviour of Selenious Acid with Sulphurous Acid.—Hans Schulze.—The author establishes that, contrary to the general opinion, sulphurous acid reduces selenium dioxide in the absence of hydrochloric. This result takes place only in certain proportions, and most decidedly when 1 c.c. of sulphurous acid solution is mixed with 10 c.c. of the solution of selenious acid. It appears that selenium may exist in a soluble state. It is the first element which has hitherto been obtained in a colloidal, soluble state.

Calorimetric Researches.—These consist of a paper by F. Stohmann and P. Rodatz, on the thermic value of the acids of the fatty series; and a memoir by F. Stohmann, on the thermo-chemical relations of the alcohols and acids of the fatty series.

Apparatus for Laboratories.—J. Walter.—The appliances described and figured are an exsiccator, with arrangement for heating, and a dropping funnel.

Smaller Communications.—E. von Meyer.—P. Richter has obtained anisic acid by preparing a solution of basic potassium para-oxybenzoate, and adding an excess of potassium methyl-ether sulphate, evaporating to dryness, stirring diligently towards the end, and putting the residue into hot dilute hydrochloric acid. The precipitate thus obtained is re-crystallised from water to which a little alcohol has been added.—Pfitzinger, on mixing phenyl-hydrazin with benzol, has obtained a crystalline body, apparently an impurity in the phenyl-hydrazin. It forms small leaflets, greasy to the touch; it contains sulphur, is insoluble in water, scarcely soluble in benzol, and melts at 96°. Pfitzinger is engaged with the examination of this product.

On Certain Methylene Compounds.—L. Henry.—From the *Comptes Rendus*.

Justus Liebig's Annalen der Chemie,
Vol. ccxxx., Part 3.

On Chlorine Monoxide.—K. Garzarolli-Thurnlackh and G. Schacherl.—The author assigns to this compound the formula Cl_2O. Liquid chlorine monoxide is dark brown, its vapour a yellowish brown. It is not, as it is commonly stated, decomposed on brief exposure to the sun's rays. Its solution in water is of a fine golden-yellow colour. The gas has a very unpleasant odour and attacks the respiritory organs severely. The vapour-density of this compound was found in two experiments as 43·69 and as 43·42; calculation gives it as 43·35.

Communications from the Chemical Laboratory of Greifswalder.—These consist of memoirs by Dr. H. Hasse on amido-toluol disulphonic acid; by Dr. G. Foth on nitro-toluidin sulphonic acid; by Dr. L. Richter on two disulphonic acids of paratoluidine; and by Dr. J. Sartig on ortho-amido-metaxylol sulphonic acid.

Volumetric Determination of the Alkaline Earths and of Combined Sulphuric Acid.—O. Knöfler.—Reserved for insertion at some length.

On Lupanine.—Max Hagen.—Lupanine is an alkaloid obtained from the seeds of *Lupinus angustifolius*. It is obtained as a syrup of the consistence of honey, of a pale yellow colour with a green fluorescence. It has a strong alkaline reaction, an intensely bitter taste, and an unpleasant odour like that of hemlock. The alkaloid forms with hydrochloric acid white clouds like ammonia. It expels ammonia from its salts. In an excess of cold water it forms a turbid solution and is almost entirely deposited on the application of heat. It dissolves with difficulty in cold alcohol, but readily in ether and chloroform. Baumert's lupinine (from *Lupinus luteus*) and lupinidine do not occur in *L. angustifolius*. The seeds of this latter species contain no other alkaloid than lupanine, $C_{15}H_{25}H_2O$, a monacid tertiary amine.

Vol. ccxxxi., Part 1.

Communications from the Physico-Chemical Laboratory of the University of Leipzig.—These consist of papers by W. Epstein, on the condensation of cinnamic aldehyd with acetacetic ether and ammonia; and by Franz Engelmann, on the action of acetaldehyd and ammonia upon acetacetic ether or benzoyl-acetic ether.

On the Non-Crystalline Products of the Action of Diastase upon Starch.—H. T. Brown and Dr. G. H. Morris. Among the principal results of this investigation are:—If extract of malt is allowed to act upon starch-paste at any temperature above 40°, the specific rotatory power of the total product and that of reducing copper oxide are such as to be explained only by the exclusive presence of maltose and a non-reductive dextrine of $[\alpha]$ 13.86, 216°. If the products of such a transformation are fractionated with alcohol, the optical and the reductive products of the several fractions are fully in harmony with the assumption that these products consist exclusively of maltose and dextrine.

Bulletin de la Société Chimique de Paris.
Vol. xliv., No. 11, Dec. 5, 1885.

On Three New Compounds of Rhodium.—Camille Vincent.—The author has obtained the rhodio-chlorides of mono-, di-, and trimethyl ammonium. The first of these compounds forms long, slender crystals, of a deep garnet-red colour. They are anhydrous, and unalterable even at 140°. The dimethyl ammonium compound is deposited in large ortho-rhombic prisms, of a dark garnet-red colour. They contain 3 mols. of water, and are efflorescent. The tri-compound forms long garnet-coloured prisms, very soluble, containing 9 mols. of water. They are very unstable.

Bulletin de l'Association des Elèves de M. Fremy.
October, 1885.

This issue also contains no original papers on chemical subjects.

Archives Neerlandaises des Sciences Exactes et Naturelles. Vol. xx., Part 3.

Chemical Equilibrium in Gaseous Systems or in those Existing in Dilute Solution.—J. H. van't Hoff. —An extensive memoir, illustrated with a number of diagrams.

Bulletin de la Société Encouragement pour l'Industrie Nationale. 3rd Series, vol. xii., September, 1885.

On Oxygenated Water.—A translation from the *Chemiker Zeitung.*

MISCELLANEOUS.

Science in Japan.—S. Tegima, Minister of Education, Tokio, Japan, has obtained leave to have translated into Japanese Prof. Guthrie's Syllabus of Instruction in Elementary Practical Physics as pursued at the Physical Laboratory of the Normal School of Science and Royal School of Mines, South Kensington. The Japanese Government proposes to introduce this system of practical instruction into the elementary schools as well as into the normal schools of Japan. Prof. Guthrie has promised to write a preface to the translation.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Phosphorus.—Can any of your readers inform me if, up to the present time, any efforts have been made to extract phosphorus either from fossil bones, phosphate of lime, or from phosphoretted iron ores of the oolitic or lias series, either in England or abroad? And if so, have the attempts proved either scientifically or commercially a success?—Enquirer.

MEETINGS FOR THE WEEK.

Monday, 18th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Friction," by Prof. H. S. Hele Shaw.
Tuesday, 19th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "The Astronomical Theory of the Great Ice Age," by Prof. R. S. Ball.
— Pathological, 8.30.
Wednesday, 20th.—Society of Arts, 8. "Results of Experiments on Mechanical Motors for Tramways made by the Commission at the Antwerp Exhibition," by Capt. Douglas Galton.
—— Meteorological, 7. (Anniversary).
Thursday, 21st.—Royal, 4.30.
—— London Institution 7.
—— Royal Society Club, 6.30.
—— Chemical, 8. "Influence of Silicon on the Properties of Cast-iron, Part III.," by Thomas Turner. "Chemical Action of Pure Cultivations of Bacterium aceti," by Adrian J. Brown. "Separation and Estimation of Zirconium; and Notes on the Analysis of Koppite," by Dr. G. H. Bailey. "The Mono-bromophthalic Acids," by E. Stallard. "Mercury Sulphites and the Constitution of Sulphites," by Dr. Divers and T. Shimidzu. "Benzoylacetic Acid and some of its Derivatives," by Dr. W. H. Perkin, jun., and A. Calman.
—— Royal Institution, 3. "The Astronomical Theory of the Great Ice Age," by Prof. R. S. Ball.
Friday, 22nd.—Quekett Club, 8.
—— Society of Arts, 8. "Burma; the Eastern Country and the Race of the Brahmins," by J. George Scott (Shway Yoe).
Saturday, 23rd.—Royal Institution, 3. "The Astronomical Theory of the Great Ice Age," by Prof. R. S. Ball.
—— Physical, 3. "Note on the Paper by Prof. W. Ramsay and Dr. S. Young, on Some Thermodynamical Relations," by Profs. Ayrton and Perry. "Note on the Paper by Mr. J. W. Clark, on the Determination of the Heat-Capacity of a Thermometer," by A. W. Clayden.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1365.

SCIENCE IN THE LAW-COURTS.

We regret to find that whilst almost every disinterested person views the present position of experts in the law-courts with dissatisfaction, few are willing to discuss this important public question. Our contemporary, the *Journal of Gas Lighting*, however, forms an exception, and accuses us of having, in our article of Jan. 1, treated his "temperate plea" with abuse and even ridicule. Where the abuse and the ridicule in our reply are to be found is not clearly apparent. We certainly called in question a remarkable assertion that the Courts in the Strand are the "supreme Temple of Arts, Sciences, Literature, and Humane Culture." This contention he has neither justified nor withdrawn, though he has now toned it down, pronouncing the "examinations and cross-examinations of expert witnesses as marking the high water level of the departments of human activity for which they speak"—a very different proposition. But we must here ask whether a Scientific Commission acting as Assessors would not perform the same task much more satisfactorily, because no one would have the opportunity to interrupt, to misinterpret, or to perplex judges and jury?

We have pointed out the errors of our contemporary in pronouncing the Royal Society and other learned societies "educational institutions," and we have shown that in papers read before such societies, or communicated to scientific journals, great men—or for that matter small men—cannot "circulate rubbish." These points, though damaging to his argument, the *Journal of Gas Lighting* now passes over. But he writes, "would any patentee . . . rest content with a *colourless report* (*sic!*) such as would be compiled with reference to his claims by a disinterested Scientific Commission?" Why should he not, unless he has reason to fear the pure white light of truth? Coloured testimony is the very evil against which we are contending, and we have to thank our contemporary for having thus, in the passage just quoted, admitted that the reports of Assessors such as we recommend would be the truth, and, as far as human knowledge extends, the whole truth and nothing but the truth.

The *Journal of Gas Lighting* further writes:—"It really appears that our contemporary is so scandalised at the propensity of men of science, when in the witness-box, to manipulate facts, that it would spare them the temptation. It is scarcely a complimentary view of the character of men of science." Now if the *Journal of Gas Lighting* will kindly refer to the article in *Nature* for Nov. 26, he will find that it is not we who take an uncomplimentry view of the character of men of science. Our object is to render it impossible for gainsayers to speak of experts as it is there done.

Our contemporary feels—or, if we may borrow an expression of his own, feigns to be—astounded that we should consider unwarranted assumptions, slips, and blunders as the outcome of the system of examination and cross-examination. But he surely does not think that such flaws would be found in the reports which we recommend. On the present system the expert, however conscientious and however thoroughly he may be master of the subject, unless he also possesses the "coolness, the verbal dexterity, the ready wit," and other attributes enumerated by *Nature*, may often fall into such mistakes. Fall, do we say? It is the very object of opposing counsel to lead or drive him into them. Nay, we must not forget the admission of *Nature*, that "too much knowledge or conscience" are not the qualities to enable a scientific witness to hold his own in a court of law.

It is perfectly true there exist "one-sided reports, papers written to order, advertising addresses, &c." But are these ever produced by members of a body such as the Assessors whom we are proposing?

Our objects in this discussion are to spare the money of litigants, to economise the time of the Courts, to enable judges and juries to see the truth directly and not through the intentionally perturbing medium of a sharp and one-sided Q.C., and last, though not least, to place scientific experts in a more worthy position and guarantee them against the insults to which they are now exposed in the witness-box. We can only regret that our contemporary does not see his way to co-operate for the attainment of such ends.

A NEW METHOD FOR SEPARATING ARSENIC FROM THE ALKALINE EARTHS.

By L. W. McCAY, M.A., D.Sc.

G. Chancel* was the first chemist to propose the use of argentic nitrate as a suitable means for separating P_2O_5 from the alkaline earths. His method is recommended by Fresenius,† who pronounces it good and convenient.

Some time ago Drs. Kratschmer and Sztancovánszky,‡ in an article upon the estimation of P_2O_5 with silver, brought out the results of their work upon the separation of P_2O_5 from the alkalies and alkaline earths with argentic nitrate. Their test analyses are numerous and very satisfactory. The ease, sharpness, and accuracy of the process lead these chemists to tend it their highest recommendation.

Now since it is possible, by means of silver solution, to effect a complete separation of P_2O_5 from the earths, reasoning analogically, the presumptions are that, in a similar manner and by similar means, As_2O_5 can be satisfactorily separated from this group of oxides.

During the last year I have been engaged in an exhaustive examination of the Reich method for determining arsenic, which, it will be remembered, depends on the fact that argentic arseniate is insoluble in water; and having been once or twice in the position to separate As_2O_5 from the alkaline earths, it seemed feasible to try whether, by observing proper precautions, it would not prove possible to accomplish the separation by the aid of argentic nitrate.

To test the matter I dissolved 5 grms. H_2KAsO_4, 1 grm. $Ba(NO_3)_2$, 1 grm. $Sr(NO_3)_2$, 1 grm. $Ca(NO_3)_2$, and 1 grm. $Mg(NO_3)_2$ in a little dilute nitric acid, and diluted the solution to 500 c.c. Every 10 c.c. contains, theoretically, 0·0416 grm. As = 0·0638 grm. As_2O_5. By actual analysis of the dihydro-potassic arseniate I found a quantity which would represent, per 10 c.c., 0·0413 grm. As = 0·0633 As_2O_5.

I proceeded as follows:—10 or 20 c.c. were pipetted into a little beaker, 50 c.c. water were added, and the liquid was heated to boiling. More than a sufficient quantity of argentic nitrate to combine with the As_2O_5 was then run in, the beaker was removed from the flame, and its contents were rendered very faintly alkaline. This was accomplished by bringing the beaker under a clip burette containing dilute ammonic hydrate, and permitting the alkali to drop in slowly, the contents of the glass being kept in a constant and violent state of agitation. By means of this vigorous stirring the argentic arseniate is made to coagulate and settle completely, leaving the supernatant liquid clear and limpid. As soon as the very

* *Comptes Rendus*, 49, 997.
† "Einleitung zur Quant. Chem. Analyse," 6 Aufl., I.B., S. 523
‡ *Zeits. f. Anal. Chem.*, 21 Jahrgang, 1882, S. 523.

dilute ammonic hydrate no longer produced a cloud in the clear upper stratum of liquid, and the reaction of the same was just* alkaline, the contents of the beaker were again well stirred, and the whole was permitted to stand until cold. This cooling was generally hastened by placing the beaker in a dish of cold water. The liquid was thereupon filtered, the reddish brown precipitate of argentic arseniate washed by decantation, and (1) dissolved in nitric acid and the silver determined *à la* Vollhard; or (2) dissolved in ammonic hydrate, caught, evaporated, and weighed in a little thin platinum dish.

(1.) $324Ag = 75As = 115As_2O_5$.
(2.) $463Ag_3AsO_4 = 75As = 115As_2O_5$.

Volumetrically.

I.

C.c.	Grm. H_2KAsO_4.	C.c. N/20KCNS.†	Grm. As.	Grm. As_2O_5.
10	0·1	16·4	0·0410	0·0628
10	0·1	16·4	0·0410	0·0628
10	0·1	16·5	0·0412	0·0632
10	0·1	16·5	0·0412	0·0632

As present = 0·0413 grm.
As_2O_5 present = 0·0633 grm.

II.

C.c.	Grm. H_2KAsO_4.	C.c. N/20KCNS.	Grm. As.	Grm. As_2O_5.
20	0·2	32·9	0·0823	0·1261
20	0·2	32·9	0·0823	0·1261

As present = 0·0826 grm.
As_2O_5 ,, = 0·1266 ,,

The filtrates were in this case carefully tested for arsenic, but with negative results.

Gravimetrically.

III.

C.c.	Grm. H_2KAsO_4.	Grm. Ag_3AsO_4.	Grm. As.	Grm. As_2O_5.
10	0·1	0·2535	0·0410	0·0628
10	0·1	0·2532	0·0410	0·0628
10	0·1	0·2540	0·0411	0·0631

Here each precipitate, after weighing, was dissolved in nitric acid and titrated. I obtained:—

	C.c.		Grm.		Grm.	
(1.)	16·4	N/20KCNS	= 0·0410	As	= 0·0628	As_2O_5.
(2.)	16·4	,,	= 0·0410	,,	= 0·0628	,,
(3.)	16·5	,,	= 0·0412	,,	= 0·0632	,,

The presence of small quantities of Fe_2O_3 and Al_2O_3 in no way affects the accuracy of the results. As a proof of this statement I offer the two following estimations—to (1) three and to (2) six drops of a moderately strong nitric acid solution of Fe and Al were added. The hydrates of these metals are indeed precipitated along with the argentic arseniate. But they do not interfere with the subsequent determination of the arsenic, inasmuch as they simply dissolve in the nitric acid or are left intact by the ammonic hydrate. The tests were made volumetrically.

(1.) 20 c.c. required 32·85 c.c. N/20KCNS = 0·0821 grm. As = 0·1260 As_2O_5.
(2.) 20 c.c. required 32·90 c.c. N/20KCNS = 0·0823 grm. As = 0·1261 As_2O_5.

The method works well, and I have no hesitation in recommending it.

In the analysis of such minerals as pharmacolite, berzeliite, and haidingerite it will be found extremely convenient.

Princeton, N.J., U.S.A.
Dec. 15, 1885.

* If too much alkali be added the excess can be removed by means of a drop or two of dilute acetic acid.

† Modern System. *See* Clemens Winkler's little work, "Die Massanalyse nach neuem titremetrischem System."

ON THE VOLUMETRIC METHOD OF DETERMINING ALUMINA.*

By Dr. K. T. BAYER.

In the Chemical News, vol. lii, p. 311, is an article by R. W. Atkinson on my method of titrating alumina. In the first place, I must express my gratitude for the trouble he has taken in submitting my process to investigation. Nevertheless, I cannot help submitting here a brief reply to, and perhaps correction of, his statements.

I regret not having been sooner acquainted with the researches of R. T. Thomson, which would have saved me much trouble and work in searching for a suitable principle for my purpose. But I must remark that the article which appeared in the December issue of the *Zeitschrift fur Analytische Chemie* had been sent a full year previously to the editors of that journal, though subsequent additions and, in part at least, causes of a personal character delayed its appearance.

In the meantime I despatched to the editors of the *Zeitschrift fur Analytische Chemie* the MS. of a second memoir on this subject, giving more exact details on the execution of the process. At first I obtained as uncertain results in the titration—especially on employing litmus—as those mentioned by Mr. Atkinson, until I succeeded in discovering the conditions under which the results become trustworthy. I must therefore refer to this second memoir, mentioning here merely that I also use phenolphthalein, and that I soon abandoned litmus.

As regards the second point mentioned by Mr. Atkinson,—the difficulty in detecting the final reaction when using tropeoline as indicator—I certainly in my memoir recommended the use of the comparative liquid for "inexperienced" operators; but I must here remark that the use of this comparative liquid is indispensable, since, as Mr. Atkinson very justly observes, without this precaution an error of 0·2 to 0·3 c.c. may be readily committed by using too much normal acid.

In titration with tropeoline as indicator, I add quite at the beginning an excess of normal acid, so that the liquid may retain its red colour, even after standing for two to three minutes and being well stirred. I then titrate back with normal soda. If the acid has at the outset dissolved all the alumina the precise neutralisation appears to be more easily effected with soda than by the inverse procedure.

By operating in this manner, with some practice exactly the same values will be obtained in two or more successive titrations of the same liquid. Any differences which may occur range at the outside up to 0·1 c.c., no matter how many c.c. of sulphuric acid have been taken. In order to eliminate this error as far as possible, it is well to use so much of the liquid to be titrated that the sulphuric acid to be used for the alumina may amount to at least 12 to 15 c.c., or, in other words, that it contains 0·2 to 0·3 grm. Al_2O_3.

St. Petersburg, Dec. 27, 1885 (Jan. 8, 1886).

* Communicated by the Author.

A Characteristic Reaction of the Sulpho-conjugated Derivative of Magenta.—Dr. C. Blarez.—One of the most sensitive reagents for detecting this compound is lead dinoxide or plumbic acid. All the red derivatives of coal-tar and the red vegetable colours in a dilute aqueous solution are completely decolourised if shaken up for some time with lead dioxide. If the aqueous solution, in place of being neutral, is slightly acidulated, especially with tartaric acid, all these reds are likewise decolourised except sulpho-conjugated magenta. This process is particularly applicable to the detection of this colour in sophisticated red wines.—*Journ. de Pharm.*, 1, 1886.

A NEW METHOD OF PRECIPITATING AND ESTIMATING MANGANESE, ALSO IRON INDIRECTLY, BY MEANS OF HYDROGEN PEROXIDE.

By JOHN JAMES BARLOW.

VALENTIN, in the 4th Edition of his "Qualitative Analysis," page 30, says that—"On exposing an ammoniacal solution of the soluble double chloride of manganese—($2NH_4Cl,MnCl_2$),—to the action of the air, the whole of the manganese is gradually precipitated as dark brown dimanganic-dioxydihydrate,—

$$\left\{\begin{matrix}MnOHO\\MnOHO\end{matrix}\right.$$

and that this reaction is characteristic for manganese compounds."

Now, I find that if I blow air into this solution, the same thing happens much quicker, the length of time required for blowing to complete precipitation depending on the amount of manganese present. The equation expressing the change which occurs may be written thus :—

$$2(2NH_4Cl,MnCl_2)+4NH_3+3H_2O+O=$$
$$=Mn_2H_2O_4+8NH_4Cl.$$

According to this equation, it is evident that before any change can take place the water must be decomposed, the hydrogen combining with the chlorine in the manganous chloride, MnCl, to form HCl; which HCl immediately combines with the excess of ammonia present, and part of the hydrogen combining with the manganese along with the oxygen of the water and the free oxygen to form the compound $Mn_2H_2O_4$.

These facts explain why it takes such a long time to precipitate the manganese, which has occupied me more than one hour to precipitate about 0·2 grm. of manganese completely.

I find, however, that if, instead of air, I use a solution of hydrogen peroxide, I obtain a complete precipitation of the manganese almost immediately; the precipitate settles rapidly, is easily filtered, and completely insoluble in NH_4Cl,NH_4HO, and ammonium salts generally; is close-grained, and if dried on a filter can be easily detached from the same; nor does the precipitate bring down any of the oxides of Zn, Ni, or Co.

From the foregoing facts I have worked out and arranged a method of separating the metals in the manganese group, *i.e.*, the metals Fe, Cr, Al, Zn, Mn, Ni, and Co., in a different manner from what has hitherto been adopted, and from my own experience it is very much simpler, quicker, easier to manipulate, does not require so many reagents, and also gives more accurate results than is obtained by any of the other well-known methods. From the table found below it will be seen that the manganese is precipitated immediately after the iron group is precipitated, which is a very great advantage whenever zinc is present, as I have found from a great many experiments. What occurs during the reaction may be represented by the following equations :—

$$(1.)\quad 2(2NH_4Cl,MnCl_2)+3H_2O_2=$$
$$=Mn_2H_2O_4+4NH_4Cl+4HCl+O_2.$$

The hydrochloric acid combines, immediately it is formed, with the excess of ammonia which is present, and so forms ammonium chloride, NH_4Cl, thus,—

$$(2.)\quad 4HCl+4NH_4HO=4NH_4Cl+4H_2O,$$

an additional advantage whenever magnesium compounds are present.

At the time the precipitation occurs, there is a rapid effervesence, due to the evolution of oxygen gas, and I find that, after adding the hydrogen peroxide, it is best to always boil before filtering, and so drive out the oxygen.

I also find that it is not at all necessary to have the manganese in the form of a soluble double chloride, nor to use a quantity of NH_4Cl along with the ammonia. I can obtain quite as accurate results from a solution of manganous chloride, $MnCl_2$, if I use a large excess of NH_4HO, minus the ammonium chloride, excepting, of course, when magnesia is present.

There is always the same difficulty, during a quantitative separation of and estimation of iron and manganese as formerly; simply on account of the utter impossibility to entirely separate the last traces of manganous hydrate from the ferric hydrate precipitate; when the iron is precipitated by ammonia or ammonium carbonate, even on precipitating and re-dissolving the red precipitate three times in succes-

TABLE FOR SEPARATING THE METALS OF THE MANGANESE GROUP.

To the solution containing the Zn, Mn, Ni, Co, Fe, Cr, and Al as chlorides, as well as the chlorides of Ba, Ca, Sr, Mg, Na, and K, add a few drops of HNO_3; boil, then add a strong solution of NH_4Cl and NH_4HO in excess; boil and filter. Re-dissolve the precipitate with HCl, add NH_4HO in slight excess; boil, filter, and mix the two filtrates.

Precipitate—Consists of $Fe_2(HO)_6$, $Cr_2(HO)_6$, and $Al_2(HO)_6$, and also a small trace of $Mn(HO)_2$.* Separate the Fe, Cr, and Al by the usual methods.

Filtrate—Contains the chlorides of Mn, Ni, Co, Zn; also the chlorides of the alkalies and alkaline earths. Warm gently, add NH_4HO to excess,† then a solution of hydrogen peroxide, drop by drop, as long as a precipitate falls down;‡ boil and filter.

Precipitate—Consists of manganese as $Mn_2H_2O_4$. Confirm by fusing on Pt foil with fusion mixture.

Filtrate—Contains $ZnCl_2$, Ni_2Cl_6, Co_2Cl_6, as well as the chlorides of the alkalies and alkaline earths. Add NH_4HO and $(NH_4)_2S$ in slight excess; filter, wash with H_2S water. (Reserve the filtrate and examine it for Ba, Sr, Ca, Mg, Na, and K). Pour dilute HCl (1 : 3) on the precipitate.

Solution—Contains the zinc as chloride. Add NH_4HO and $(NH_4)_2S$. White precipitate confirms zinc.

Residue—Consists of the sulphides of Ni and Co. Examine and separate these by the usual methods.

* If no precipitate is obtained on adding H_2O_2 a little of the precipitate obtained with NH_4HO should be tested for Mn by fusing on Pt foil, as it is impossible to separate a mere trace of Mn when the NH_4HO precipitate is large.

† If there is not an excess of NH_4HO no precipitate is obtained.

‡ Whilst the H_2O_2 is being added strong effervescence occurs, due to the evolution of oxygen gas. The precipitated Mn settles out very clean and rapidly, and is easily filtered.

sion, I could still get the characteristic green manganate of soda by fusing with a little of the red precipitate with fusion mixture on platinum foil; but if no iron was present with the manganese I had not the slightest difficulty, and I obtained very good results indeed.

To overcome the above-mentioned difficulty of estimating accurately both the iron and the manganese, when present together, I use the following process, which gives splendid results.

To the solution containing the chlorides of iron and manganese (other metals may be present, excepting chromium and aluminium, though the best results are obtained if foreign substances are absent) I add a solution of NH_4Cl, then strong NH_4HO in excess; boil, then add lastly hydrogen peroxide solution as long as a precipitate falls, then boil a minute or two, filter, wash two or three times with hot water, ignite, and weigh the mixed oxides together as mixture of $Fe_2O_3+Mn_3O_4$.

I then put the mixed oxides of iron and manganese into a little flask (holding about 70 c.c.), and distil in hydrochloric acid, passing the evolved chlorine gas into KI solution, and then estimating the amount of iodine liberated by a standard solution of sodium hyposulphite.

The weight of the mixed oxides obtained, minus the weight of the Mn_3O_4, gives the amount of Fe_2O_3.

In precipitating both metals with H_2O_2 there is a great advantage over the old method of precipitating by means of NaHO or Na_2CO_3, as hydrate or carbonate. I always obtained too much iron, on account of not washing out entirely the free NaHO or Na_2CO_3, and always too little manganese, because the manganese precipitate is slightly soluble in excess of sodium hydrate or carbonate.

By using the potassium iodide method, and precipitating both iron and manganese together, by means of hydrogen peroxide, I have found manganese, and also estimated it, in substances which have been thought, and even stated, as free from manganese, when the other methods were adopted.

Radcliffe Close Chemical Works,
Radcliffe, near Manchester.
December 28, 1885.

THE VOLUMETRIC DETERMINATION OF THE ALKALINE EARTHS, AND OF COMBINED SULPHURIC ACID.

By O. KNÖFLER.

The author uses as indicator a mixture of phenolphthalein and methyl-orange, 1 grm. of each dissolved in 250 c.c. of alcohol.

After this indicator has been added, the solution of the substance in question is mixed with hydrochloric acid to incipient acid reaction (reddening of the methyl-orange). If carbonic acid is present it is expelled by boiling. Quinque-normal sodium carbonate is then dropped in; the alkaline reaction which appeared at first disappears immediately in case of barium and strontium salts; more slowly, though within a few seconds, with calcium salts.

As soon as a faint rose-colour remains 1 c.c. more of the sodium carbonate solution is added, and the liquid, which is now a deep red, is filtered through a wet folded filter, and washed once with water. The filtrate is then titrated back with quinque-normal acid until the methyl-orange reaction appears. If a good filter is used the filtration is complete in one to two minutes; once washing is sufficient, as only from 1 to 2 c.c. of quinque-normal carbonate solution is present in excess. The final reaction with methyl-orange can be very distinctly recognised after a little practice. Boiling up is not necessary, as carbonic acid does not act upon methyl-orange.

The volume of the solution of sodium carbonate used after deduction of the c.c. of acid employed corresponds to the quantity of the alkaline earth which was present. For preparing the standard solution 10·583 grms. of anhydrous sodium carbonate, chemically pure, was dissolved in water so as to make up 1000 c.c., and the hydrochloric acid was standardised accordingly.

An excess of 1 c.c. of the sodium carbonate solution was found sufficient to precipitate all the baryta. The same quantity was found sufficient in case of strontium and calcium. Calcium carbonate falls less quickly than barium and strontium carbonates, but still within a few seconds. The precipitation is rather slower in dilute solutions, but it is still quantitative.

If the three alkaline earths are present in solution together, a portion is first titrated as above. The metals are separated, and the single constituents are either determined from the difference (after one metal has been removed from the solution), or the isolated salts are titrated with the quinque-normal sodium carbonate.

Baryta is separated from strontia and lime by means of potassium chromate. The barium chromate is either weighed or it is determined volumetrically by Wildenstein's process. Attempts to separate the barium as chromate, and to titrate the filtrate with the quinque-normal solution of sodium carbonate gave no results, as the sodium acetate (which must be added to prevent the simultaneous precipitation of strontium chromate) makes the final reaction indistinct.

Strontia is best separated from lime by treating the dry nitrates with a mixture of ether and alcohol. The solution containing the lime is easily titrated, as above, after the expulsion of the ether.

All attempts to precipitate salts of magnesia with sodium carbonate led to no result, as magnesium carbonate falls not merely slowly, but imperfectly. Such salts must not be present in determinations by the above method. The separation with ammonium chloride is inadmissible. Magnesium salts may, however, be removed along with iron, &c., by adding to the hot solution soda-lye free from carbonate, until the reaction is distinctly alkaline.

In this process the previous addition of ammonia or its salts must be entirely avoided.

In the determination of combined sulphuric acid there is required, besides the above-mentioned solutions of sodium carbonate and hydrochloric acid, a quinque-normal solution of barium chloride. The process is as follows:—The solution in question is coloured with phenol-phthalein and methyl-orange, and mixed with quinque-normal hydrochloric acid to incipient acid reaction. It is then boiled up and mixed with a few tenths of a c.c. of the standard sodium carbonate solution. This must produce a distinctly alkaline reaction (otherwise carbonic acid is present, and must be expelled by boiling). The quinque-normal barium chloride is then dropped in, with agitation. As long as sulphuric acid is in solution it seizes upon the barium. As soon as it is all precipitated any further barium chloride undergoes double decomposition with the sodium carbonate, and the alkaline reaction disappears. As the point of disappearance is not sufficiently well marked a further c.c. of the barium chloride is added; the whole is boiled up, and, without filtering, quinque-normal sodium carbonate is dropped in until the alkaline reaction appears. The mixture is then poured upon a folded filter, washed once with water, and the filtrate is titrated back with quinque-normal hydrochloric acid. The c.c. of $BaCl_2$ consumed + acid − total c.c. of quinque-normal sodium carbonate consumed, multiplied by 0·008, give grammes of SO_3.

This method is not universally applicable. Those substances must be absent which interfere with the volumetric determination of the alkaline earths. If lime is present two titrations are needed: the lime is first determined in one portion, as above, and then the sulphuric acid, either in the filtrate or in another portion of the original solution, deducting the quantity of sodium carbonate corresponding to the lime. Acids which are precipitated by barium chloride in neutral solutions must not be present.—*Liebig's Annalen.*

THE QUANTITATIVE DETERMINATION OF NIOBIUM.

By T. B. OSBORNE.

NIOBIUM occurs in Nature almost always in connection with tantalum and titanium, in the presence of which it has been heretofore impossible to obtain more than an approximate determination, on account of the close analogy of the behaviour of these three elements, when occurring together, toward reagents.

Marignac proposed in 1866 (*Arch. de Sc.*, xxv., p. 17) the process now generally employed for the determination of niobium, but, as he says in describing his method, only approximate results can be obtained by its use. His method depends on the difference in solubility of the potassium fluorine salts of tantalum, niobium, and titanium. Tantalum forms a salt of the composition TaF_52KF, dissolving at ordinary temperatures in 150 to 200 parts of water acidulated with hydrofluoric acid, and crystallising in fine needles. Niobium, on the other hand, forms a salt of the composition $NbOF_32KFH_2O$, dissolving in 12 parts of water, and crystallising in scales isomorphous with the corresponding titanium salt. The potassium titanium fluoride dissolves in 96 parts of water.

Marignac adds bifluoride of potassium to the solution of the fluorides of tantalum, niobium, and titanium, and concentrates till scales of TiF_52KF or $NbOF_32KF$ appear. The TaF_52KF is filtered and washed with the aid of a pump until the washings no longer give any orange-red precipitate with solution of galls after standing two hours. On account of the solubility of the TaF_52KF the mother-liquor containing the $NbOF_32KF$ must always be a saturated solution of TaF_52KF, and likewise a loss must occur on washing, so that even if the process of crystallisation be several times repeated, as is usually necessary, a very considerable loss must occur. Moreover, the tantalum potassium fluoride cannot be entirely freed from niobium in this way, for I found in preparing TaF_52KF that the niobium cannot be entirely removed by simply crystallising and washing, as I was compelled to re-crystallise several times before the TaF_52KF gave no evidence of the presence of niobium, when tested by reducing with zinc and hydrochloric acid. Titanium will, when present in any considerable quantity, render the application of this method still more uncertain on account of the intermediate solubility of the potassium titanium fluoride and its close resemblance to the $NbOF_32KF$.

From this description it will readily be seen that this method is open to serious objection, and can only find acceptance in want of a better. I therefore undertook an investigation of the reduction with zinc in acid solutions containing niobium, with the hope of discovering a more accurate and less difficult method of determination. The salts of tantalum and niobium I prepared from columbite from Branchville, Connecticut, in the following way:—The mineral was ground to pass a sieve of 100 meshes to the inch, and 500 grms. fused with bisulphate of potassium in a platinum dish, 100 grms. at a time. When thoroughly fused the mass was immediately poured into cold water, which caused the separated tantalic and niobic acids to granulate and expose a large surface to the action of the water, whereby the solution of the bisulphate of potassium was very materially promoted, and the lumps broke up easily on stirring, the tantalic and niobic acids separating partly in a flocculent and partly in a granular form.

After washing by decantation the residue was treated with ammonium sulphide, and then filtered and washed to remove any tin or tungsten which might be present. Hydrochloric acid was then added, and, after washing, the residue was obtained free from iron and manganese. The residue was next treated with hydrofluoric and sulphuric acids, in order to remove any silica, precipitated with ammonia, and washed free from sulphates. The tantalic and niobic acids thus obtained were dissolved in an excess of hot hydrofluoric acid and carbonate of potassium added gradually, and, after cooling, the TaF_52KF filtered off. The crude TaF_52KF was re-crystallised several times, and washed till no reduction whatever took place on testing with zinc and hydrochloric acid. The mother-liquor from the crude TaF_52KF was then nearly neutralised with carbonate of potassium, which caused the solution to nearly solidify from the formation of $NbOF_52KF$. This product was then re-crystallised several times, and tested for tantalum by boiling with pure water, when, according to Marignac, if the slightest trace of tantalum were present, it would separate as an oxyfluoride. None was found. Analyses of the $NbOF_32KFH_2O$ thus obtained gave the following results:—

			Calculated.
H_2O	5·92	5·90	5·97
NbO	36·92	36·84	36 87
K_2	26·07	26·13	25·97
F_5	31·09	31·13	31·19
Ti	trace	trace	—
	100·00	100·00	100·00

This analysis shows that the salt was practically pure. The trace of titanium was found by testing with H_2O_2, and amounted to only 0·0066 per cent.

Tantalum when treated with zinc and hydrochloric acid does not reduce. Niobium, on the other hand, forms apparently several reduction products, or at least exhibits colours varying according to treatment. When zinc is added to a dilute hydrochloric acid solution of niobium, a blue colour is formed in the cold; if the acid is strong a brown colour is obtained, which, if the acid is allowed to act on the zinc until nearly neutralised, changes to blue, and an indigo-blue precipitate separates out. When heated to 100° only quite dilute acid solutions give a blue colour, which speedily turn brown. Those containing more acid give a brown colour at once. If sulphuric acid is used instead of hydrochloric, the blue colour appears at first, but on heating with much acid this passes into a brown differing slightly in colour from that produced in the hydrochloric acid solution. A grass-green colour is often obtained in the cold, with both sulphuric and hydrochloric acids, which appears to be intermediate between the blue and the brown as the blue passes into green and this into brown. All solutions strongly acidified with sulphuric or hydrochloric acid give on heating a dark brown colour, which evidently indicates the lowest reduction attainable, while the blue colour marks a higher oxide than the brown or else an incomplete reduction.

The solution reduced with sulphuric acid and zinc is much less stable than that with hydrochloric acid, for on pouring it while warm into water, if the amount of reduced niobium is sufficient, an evolution of hydrogen takes place from the decomposition of the water. With hydrofluoric acid and zinc a violet colour is produced similar to that given by titanium with zinc and sulphuric acid. Under similar conditions titanium gives a green colour.

The first attempts at a quantitative determination of niobium were made with sulphuric acid solutions of $NbOF_32KF$, as sulphuric acid is better suited for titration with potassium permanganate than hydrochloric. It was found, however, that the amount of reduced niobium was very far from constant. More constant results were obtained by pouring the reduced solution into ferric sulphate, but these varied too widely to give any promise of a satisfactory method. Hydrochloric acid was then tried, and iodine solution added till a drop gave a blue colour with a drop of starch solution; then sodium thiosulphate solution in slight excess, then a few drops of starch solution and iodine added till a blue colour appeared. It was found, however, that a dark brownish colour was formed near the end of the titration which so obscured the blue of the starch that very unsatisfactory results were obtained.

I then tried potassium dichromate for titrating, pouring the reduced solution into ferric chloride, but without success.

Potassium permanganate was then returned to, and manganese sulphate or magnesium sulphate added to prevent the action of the hydrochloric acid on the permanganate. It was afterward found that by sufficient dilution the end point could be obtained with all the accuracy desirable without the addition of either magnesium or manganese sulphates. The results are shown in the following table. The reduction was assumed to be to Nb_2O_3.

Amount of acid used.		Amount of $NbOF_32KFH_2O$.	Time of reduction.	Percentage of Nb_2O_5.
50 c.c. HCl sp. gr. 1·1		0·5155	½ hour.	34·24
,,		0·4652	,,	35·21
,,		0·4932	,,	35·58
,,		0·5900	,,	34·90
,,		0·5561	,,	34·50
,,		0·6614	,,	35·24
,,		0·4926	1½ hours.	34·01
,,		0·5896	,,	34·60
40 c.c. ,,		0·4982	½ hour.	34·27
,,		0·4161	,,	34·13
30 c.c. ,,		0·5291	½ hour.	33·56
50 c.c. ,,	(conc.)	0·5219	½ hour.	37·68
,,		0·8122	,,	38·41
,,		0·4256	,,	36·74
,,		0·7152	,,	37·65
25 c.c. ,,	(conc.)	0·4421	,,	36·97
,,		0·5162	,,	37·54
,,		0·3910	,,	37·40
,,		1·0592	,,	38·07
,,		0 8890	1 hour.	37·56
,,		0·9274	,,	35·90
,,		6·6734	½ hour.	38·58
,,		0·6861	,,	38·78
,,		0·5980	,,	38·30
,,		0·5828	,,	38·70
,,		0·7611	,,	37·68
,,		0·6530	,,	38·07

(Contained about 0·5 gr. TaF_32KF.)

In the above analyses the fluorides were dissolved in water, and the acid added. In the following concentrated acid was added directly to the fluorides .. .. 1·1023 ,, 39·03

0·8395 ,, 38·86

The amount Nb_2O_5 corresponding to the niobium in the $NbOF_32KFH_2O$ is .. .. 44·48

The foregoing series of determinations show that the reduction of the niobium is quite constant for a given strength of acid depending not on its amount, but on its strength. The determinations were made by dissolving $NbOF_32KF$ in water, and adding the indicated amount of acid. The first eight determinations, where 50 c.c. of dilute acid were used, give an average of 34·78. With 40 c.c. the same amount of water was used to dissolve the fluoride; the strength was consequently less, and the average lower, being 34·20. With 30 c.c. 33·56 was found. When concentrated acid was used the amount of water required to dissolve the fluorides was small in comparison with the amount of the acid in solution, so that the amount of water used exerted but little influence on the reduction, but the increased strength of acid raised the average to 37·80. The results obtained when concentrated acid was used to dissolve the fluoride are higher still, the average being 38·94.

Thus we have—

For 30 c.c. HCl, sp. gr. 1·1 .. .. 33·56 p.c. Nb_2O_5.
,, 40 c.c. ,, ,, ... 34·20 ,, ,,
,, 50 c.c. ,, ,, ... 34·78 ,, ,,
,, Concentrated HCl .. .. .. 37·80 ,, ,,
,, Fluorides dissolved in conc. HCl 38·94 ,, ,,

It appears therefore that the amount of reduction increases with the concentration of the acid. The formula for an oxide corresponding to the reduction in the last case would be Nb_8O_{13}. Marignac sought to obtain a formula for this oxide in the same way, and obtained Nb_3O_5. This is very nearly equal to Nb_8O_{13}, since for 8 atoms of niobium there would be 13⅛ atoms of oxygen according to his formula. It is probable that neither of these oxides represents the oxide formed, but that a partial reduction has taken place, as will appear from the results obtained from niobic acid in the following manner:—Ten grms. of $NbOF_32KF$ and 5 grms. of TaF_32KF were accurately weighed, and heated with sulphuric acid in a platinum dish till all the hydrofluoric acid was removed. The acid solution was poured into water, and precipitated with ammonia, washed by decantation, and then thoroughly dried at 100° C. Weighed portions were then ignited, and the total amount of mixed oxides of tantalum and niobium determined. The percentage of niobic oxide in these mixed oxides was calculated from the relative amount of the fluorides of each metal taken. In this way it was found that the mixture of tantalic and niobic acid precipitated and dried at 100° contained 47·36 per cent of Nb_2O_5. Weighed portions were then dissolved in as small an amount of hydrofluoric acid as possible, and 50 c.c. of concentrated acid added, and the reduction carried on at a temperature of about 80° C. for three-quarters of an hour. The amounts obtained were as follows:—

Amount of mixed oxides taken.		Amount of Nb_2O_5 found.
0·6400		46·99
0·6652	Nb_2O_5 present.	47·45
0·7455		46·70
0 7603	47·36 per cent.	46·64
0·8323		46·97

In the above determinations the reduction was evidently to Nb_2O_3. Marignac states that alkali fluorides impede the reduction, and this would explain why the reduction in the foregoing determinations was complete, while in those where the potassium fluoride of niobium was used it was incomplete: as the amount of alkali fluoride was always in the same proportion to the amount of tantalum and niobium constant results might be expected, but it is remarkable that so small an amount of alkali fluoride should exert so great an influence on the reduction, and that the hydrofluoric acid added to dissolve the niobic acid did not also interfere with the reduction. Two analyses were made in order to throw light on this point by adding weighed amounts of potassium fluoride to a mixture of tantalic and niobic acids free from fluorides and containing 45·99 per cent of Nb_2O_5.

Weight of mixed acids.	Weight of KF.	Nb_2O_5 found.	Nb_2O_5 present.
5696	0·0900	43·83	45 99
5405	0·3728	43·87	—

From this it would appear that the *amount* of alkali fluoride exerted no influence, but that its *presence* did. In this case, however, the reduction is proportionally greater than when $NbOF_32KF$ was used.

The influence of titanium was next studied. Titanic acid was treated exactly as the niobic acid, and the following results were obtained:—

TiO_2 found by reduction and titration.		Present.
20·38	20·36	20·48

In order to determine whether both niobium and titanium would reduce together as well as separately the oxides were mixed together, and the niobium determined by deducting from the amount of permanganate used the amount necessary to oxidise all the reduced titanium, and calculating the niobium corresponding to the balance. In this way I obtained the amounts given below:—

Mixture of three acids.	Titanic acid present.	Nb_2O_5 present.	Nb_2O_5 found.
1·1798 grms.	0·0859 grm.	0·4928 grm.	0·4907
0·8145 grm.	0·0687 ,,	0·3357 ,,	0·3314

For the determination of titanium in the presence of niobium the method proposed by A. Weller (*Berichte*, xv., 1882, 2, p. 2592) appeared most suitable. It depends upon a comparison of the colour produced by hydrogen dioxide in an acid solution of titanic acid, with the colour of a solution containing a known amount of titanium. A. Weller, in describing his method, calls attention to its applicability to the determination of titanium in the presence of tantalum and niobium, but says he has not tried it in this case. I therefore undertook to determine the best manner of applying it. I found that it was necessary to use hydrofluoric or hydrochloric acid in order to keep the tantalum and niobium in solution when sufficiently diluted. I found that the first of these acids, even in small amounts, entirely prevented the formation of the colour of titanium with hydrogen dioxide, and that hydrochloric acid deepened it very greatly in proportion to the amount added. It is necessary, therefore, to have the solution free from fluorides, and to have the same amount of acid in the standard solution as in the solution to be analysed. It is very difficult to obtain these conditions, and I was entirely unsuccessful in my attempts to determine the amount of titanium in a solution containing much free acid. I succeeded in obtaining quite satisfactory results, however, by precipitating the strongly acid solution with a small excess of ammonia, and then redissolving the precipitate with as little sulphuric acid as possible, the freshly precipitated niobic and tantalic acids being readily soluble in dilute acid.

In order to test the accuracy of this method a mixture of tantalic, niobic, and titanic acids, containing a known amount of each acid, was dissolved in hydrofluoric acid in a platinum dish, and the excess of acid evaporated off on the water-bath. The fluorides thus obtained were dissolved in concentrated hydrochloric acid, and poured into a glass flask of about 100 c.c. capacity, the platinum dish being rinsed out with concentrated hydrochloric acid. The solution and rinsings amounted to 50 c.c. Amalgamated zinc was then added, and a piece of platinum and the solution allowed to reduce in a stream of carbonic acid for three-quarters of an hour at a temperature of about 80° C. During this process the greater part of the hydrofluoric acid was removed from the solution, going off as silicon fluoride. After cooling thoroughly the reduced solution was poured into a beaker, and diluted to 350 c.c. with distilled water freshly boiled and perfectly cold. A standard solution of potassium permanganate was added till the solution, at first nearly black, became perfectly clear, and a distinct pink colour was produced by the addition of a single drop. To the solution containing the tantalum, niobium, and titanium, ammonia was added in slight excess, and then sulphuric acid till the precipitate produced by the ammonia dissolved entirely. In this way a solution was obtained containing a very small amount of free acid, and practically free from fluorides. This solution was then diluted to 500 c.c., and 50 c.c. brought into a Nesslerising tube and 2 c.c. of hydrogen dioxide added. About 40 c.c. of water was added to another tube of the same dimensions, and then 2 c.c. of hydrogen dioxide. A solution of titanic acid, prepared by evaporating potassium titanium fluoride with excess of sulphuric acid and diluting with water until 1 c.c. equalled 1 m.grm. of titanium oxide, was then run in until the colour in the two tubes was nearly alike. They were then brought to the same volume, and the standard solution of titanium added drop by drop till there was no longer any difference in colour discernible. The number of cubic centimetres of the standard solution multiplied by 10 gave the number of m.grms. of TiO_2 in the solution analysed. By calculating the amount of permanganate solution necessary to oxidise the Ti_2O_3 formed by reduction of this amount of TiO_2, the amount of permanganate employed to oxidise the niobium was found, and from this the amount of niobium calculated. The tantalum was found by subtracting the sum of the niobic and titanic oxides from the sum of the three oxides. In this way the following amounts of each were found :—

	Nb_2O_5.	Ta_2O_5.	TiO_2.
Taken ..	0·3357 grm.	0·2246 grm.	0·0687 grm.
Found ..	0·3314 ,,	0·2289 ,,	0·0667 ,,

It is necessary that during the reduction the heat should not be too great, as the tantalic acid is liable to precipitate and to carry with it both niobium and titanium, and the reduction consequently will be incomplete. If tantalum is not present the solution can be boiled without danger. In order to analyse a mineral containing these three elements the mixed oxides can be obtained in the usual manner by fusing the finely ground mineral with bisulphate of potassium, digesting with water, filtering, heating the residue with ammonium sulphide, washing to remove tin and tungsten if present, treating the residue with dilute sulphuric acid to remove iron, washing, and igniting with ammonium carbonate. After obtaining the joint weights of the oxides, fuse with potassium bisulphate, digest with water, and the residue—washed free from sulphates—dissolve in hot hydrofluoric acid, evaporate nearly dry on the water-bath, and proceed with the reduction and determination as just described. An analysis of Branchville columbite by this method gave the following results :—

Ta_2O_5 ..	18·95	19·44	Specific gravity,
Nb_2O_5 ..	60·95	60·46	5·73
FeO	12·86	12·95	
MnO	7·07	7·00	Oxygen ratio,
	99·83	99·85	1 : 1·03

Marignac constructed a table of specific gravities of columbite which showed that in general the specific gravity increases with the amount of tantalum. The relations which he found hold good for this analysis.—*American Journal of Science*, Vol. xxx., No. 179.

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.*

By P. T. CLEVE.

(Continued from page 31.)

Oxide of Samarium, Sm_2O_3.

It forms an almost white powder, having a very slight yellowish tint. It is easily soluble in acids, and is not reduced by ignition in a current of hydrogen. If forms no higher oxide on ignition in oxygen. The oxide is very hygroscopic.

Specific gravity—

1·9113 grms., t° 15°, sp. gr. 8·383
2·1432 ,, ,, 13°, ,, 8·311

Mean of the two determinations, 8·347.
Molecular volume, 41·7.

Hydroxide of Samarium.

It is a gelatinous, white, and bulky precipitate, which absorbs carbonic acid from the air, but to a less degree than the hydroxides of the other cerium metals. It dries to yellowish semi-transparent fragments. It is not soluble in alkalies, but is easily soluble in acids, and expels ammonia from ammoniacal salts if boiled with their solutions.

Salts of Samarium.

The salts of samarium are of a yellow colour, though sometimes almost white; their concentrated solutions are

* Presented to the Royal Society of Sciences of Upsala, Feb. 13 1885.

also yellow, and give a peculiar absorption-spectrum. The taste of the soluble salts is sweetish and very astringent.

Sulphuretted hydrogen gives no precipitate with the salts of samarium.

Sulph-hydrate of ammonia precipitates hydroxide of samarium.

Alkalies precipitate completely hydroxide of samarium, insoluble in excess of alkalies.

Alkaline carbonates give gelatinous and voluminous precipitates, soluble, if recently precipitated, in excess of the reagents. After some time very slightly soluble double carbonates separate out.

Sulphate of potash gives with not too dilute solutions of salts of samarium a white precipitate, very slightly soluble in a saturated solution of sulphate of potash; 100 parts of the saturated solution contain about 0·05 part Sm_2O_3. The solubility is very much influenced by the presence of the other earths. The solubility is increased by the presence of the yttria earths.

Oxalic acid gives in neutral or slightly acid solutions a voluminous, white, and gaseous precipitate, which soon becomes pulverulent and crystalline. It is soluble in boiling nitric acid.

Alkaline oxalates give white, non-crystalline precipitates of double oxalates of samaria with oxalates of alkalies. These precipitates are finely divided and not easy to wash.

Acetate of sodium gives on boiling with dilute solutions of samaria no precipitate.

Hyposulphite of sodium produces on boiling with salts of samarium no precipitate.

Ferrocyanide of potash gives with salts of samarium a yellowish non-crystalline precipitate of ferrocyanide of samarium and potassium.

Tartaric acid gives with salts of samarium a white, voluminous precipitate, soluble in ammonia. The ammoniacal solutions of the tartrate deposit after some time at the ordinary temperature, and immediately on heating, a white powder.

Formiate of ammonia gives with concentrated solutions of salts of samarium, especially on evaporating, a white powder of little soluble formiate of samarium.

Borax and microcosmic salt give with samaria colourless beads.

Peroxide of Samarium.

If basic nitrate of samarium be heated to incipient redness in a current of dry oxygen as long as red vapours are given off, an oxide remains which has a stronger yellow tint than the oxide of samarium. The loss on heating to a white heat was found in two experiments to amount to 1·35 and 2·81 per cent. When dissolved in a solution of a known weight of ammonio-ferrous sulphate mixed with sulphuric acid it did not oxidise more of the ferrous salt than corresponds to 0·1 per cent of oxygen. It seems, then, highly improbable that a peroxide of samarium could be obtained in the manner described.

If peroxide of hydrogen (2 per cent) be added to a solution of a samarium salt no visible change occurs, but on adding ammonia a gelatinous precipitate, perfectly resembling the hydroxide of samarium, is produced. After a short while oxygen is given off in numerous small bubbles. After washing, one portion of this precipitate, suspended in the liquid, was mixed with a known quantity of ammonio-ferrous sulphate. Ferric hydroxide was immediately thrown down. After adding dilute sulphuric acid, the unoxidised excess of the ferrous salt was estimated by permanganate of potash. Afterwards the samarium was determined in the liquid by precipitation with oxalic acid, ignition of the oxalate, and re-precipitation as oxalate.

The experiment gave—

0·7818 grm. Sm_2O_3 and 0·0513 grm. O, or for 100 Sm_2O_3 6·56 O.

This corresponds pretty nearly to—

$$Sm_4O_9,$$

which requires for 100 Sm_2O_3 6·90 oxygen.

If the precipitate be dried over sulphuric acid it forms semi-transparent yellowish pieces, which were powdered several times. Afterwards it was analysed.

0·772 grm. was heated with bichromate of potash in a current of dry air, and gave 0·0178 grm. CO_2 and 0·1180 grm. H_2O.

0·7241 grm. gave by ignition 0·5581 grm. Sm_2O_3.

0·7542 grm. was mixed with 3·1386 grms.—

$$(NH_4)_2Fe2SO_4+6H_2O,$$

and water, sulphuric acid was added (when a great number of small gas-bubbles escaped), and afterwards 23·3 c.c. permanganate of potash (100 c.c. = 0·939 Fe) were required to oxidise the excess of ferrous salt.

In per cent—

		Ratio.
Sm_2O_3	77·07	1
O	4·35	1·23
CO_2	2·31	0·24
H_2O	15·28	3·83
	99·01	

The dry substance analysed, which had been obtained from the nitrate of samarium, contained also a trace of nitric acid.

On comparing the ratio between Sm_2O_3 and O in the moist and in the dry product, it will be seen that comparatively little oxygen was lost in drying.

I have examined the composition of the products formed by the action of peroxide of hydrogen upon the hydroxide of the other earths,* and have found that didymium, lanthanum, yttrium, and erbium all give products of perfectly analogous composition, or agreeing with the general formula R_4O_9, when recently washed and in a moist state. Considering that oxygen was given off immediately after the precipitation, and that products of this kind are very liable to lose oxygen, one may with some probability give preference to the formula R_2O_5. Still it is a question which cannot be answered, whether these products are really peroxides, and not a kind of hydrate containing H_2O_2, in some manner analogous to the compounds of BaO_2, Na_2O_2, &c., with H_2O_2, which were discovered by Schöne.

Sulphide of Samarium.

Oxide of samarium was ignited in a current of hydrogen saturated with vapours of bisulphide of carbon. It was blackened with carbon, but its weight was very slightly increased, so that it may be concluded that the oxide of samarium is not attacked by bisulphide of carbon at a red-heat.

Fluoride of Samarium, $2SmFl_3+H_2O$.

Hydrofluoric acid produces with solutions of the salts of samarium a whitish, transparent, voluminous, and non-crystalline precipitate, which, on heating the solution, settles down as a heavy powder in a very fine state of division. The fluoride is not soluble in dilute acids.

I. 1·0888 grms. of the fluoride, dried at 110°, gave with sulphuric acid 1·5026 grms. Sm_23SO_4.

II. 2·0857 grms., dried at 100°, gave 2·8801 grms. Sm_23SO_4.

In per cent—

	I.	II.	Calculated.	
Sm.. ..	70·41	70·45	150	69·44
Fl	—	—	57	—
H_2O ..	—	—	9	—
			216	

It seems as if a little of the water were lost at 100°, as the analyses of two different preparations gave 1 per cent. Sm too much. This is also the case with the fluorides of the other cerium and yttrium metals.

* *Bull. Soc. Chim.*, xliii., p. 53, 1885.

Chloride of Samarium, $SmCl_3+6H_2O$.

This compound forms large, tabular, topaz-coloured crystals, easily soluble in water, and deliquescent in moist air.

The analyses of the salt, already published,* gave in per cent—

		Calculated.	
Sm	41·06	150·0	41·15
Cl	28·79	106·5	29·22
H_2O (loss) ..	30·15	108·0	29·63
		364·5	100·00

Specific gravity—
1·6064 grms., coarse pieces, t° 15°, sp. gr. 2·392
1·7460 „ „ „ „ 2·375
Mean of the two determinations, 2·383.
Molecular volume, 153.

Oxychloride of Samarium, SmOCl.

When oxide of samarium is heated in a current of chlorine it increases largely in bulk, becomes incandescent, and is ultimately converted into a white, very hygroscopic powder.

1·6652 grms. of the oxide gave 1·9209 grms. of the oxychloride, or 100 grms. oxide 115·3 grms. oxychloride instead of 115·8 grms.

0·5115 grm. gave 0·4418 grm. Sm_2O_3 and 0·3613 grm. AgCl.

In per cent—

		Calculated.	
Sm	74·46	150·0	74·44
Cl	17·46	35·5	17·62
O (loss)	8·08	16·0	7·94
	100·00	201·5	100·00

Specific gravity—
0·8019 grm., t° 21° sp. gr. 7·047
0·6030 „ „ „ 6·987
Mean of the two determinations, 7·017.
Molecular volume, 28·7.

Bromide of Samarium, $SmBr_3+6H_2O$.

On evaporating over sulphuric acid a solution of oxide of samarium in hydrobromic acid, to the consistency of a syrup, large, well-developed, topaz-yellow crystals are deposited, which resemble in form crystals of gypsum. These crystals are very deliquescent, and when heated give off water and hydrobromic acid, even though mixed with excess of ammonium bromide. The whitish residue leaves on treatment with water brilliant micaceous crystals, probably of an oxybromide, which are slowly attacked by acids.

0·7634 grm. of the crystallised bromide, pressed between paper, gave 0·8540 grm. AgBr and 0·2662 grm. Sm_2O_3.

In per cent—

		Calculated.	
Sm	30·06	150	30·12
Br	47·61	240	48·19
H_2O (loss) ..	22·33	108	21·69
	100·00	498	100·00

Specific gravity—
1·0083 grm coarse pieces, t° 21·8° 2·969
0·8118 „ „ „ 2·973
Mean of both determinations, 2·971.
Molecular volume, 167·6.

Chloroplatinate of Samarium, $SmCl_3,PtCl_4+10\frac{1}{2}H_2O$.

By slowly evaporating mixed solutions of the simple chlorides large prismatic crystals of deep orange colour are obtained. The chloroplatinate is easily soluble and deliquescent. It loses at 110° about 4 mols. H_2O.

The analysis has already been published,* and gave in per cent—

		Calculated.	
Pt	24·28	195·0	24·92
Sm	19·52	150 0	19·17
Cl	—	248·5	—
H_2O	—	189·0	—
		782·5	

Specific gravity—
0·4312 grm. crystals, pressed between paper, t° 21·8°, sp. gr. 2·714.
0·7531 grm. crystals, pressed between paper, t° 21·8°, sp. gr. 2·709.
Mean of both determinations, 2·712.
Molecular volume, 288·5.

Chloroaurate of Samarium, $SmCl_4+AuCl_3+10H_2O$.

On slowly evaporating over oil of vitriol the mixed solutions of the chlorides of samarium and of gold, large, thick, and well-formed rhombic tablets of yellow colour are deposited when the solution becomes very concentrated. They are easily soluble and deliquescent.

0·4668 grm. was treated with zinc and a little dilute sulphuric acid. The remaining gold was washed with water, and finally with dilute hydrochloric acid. 0·1243 grm. Au and 0·5390 grm. AgCl were thus obtained.

0·7998 grm. was decomposed with sulphurous acid and evaporated to dryness. The residue, consisting of gold and samarium sulphate ($Sm_{23}SO_4$), weighed 0·5308 grm., and when treated with water left 0·2127 grm. Au.

In per cent—

			Calculated.	
Sm	—	20·29	150	20·30
Au	26·63	26·59	196	26·52
Cl	28·55	—	213	28·82
H_2O	—	(24·55)	180	24·36
			739	100·00
$Sm_{23}SO_4+Au$ ..	66·37		—	66·31

Specific gravity—
0·8779 grm. coarse pieces, t° 16·5°, sp. gr. 2·739
1·2829 „ „ „ „ 2·744
Mean of the two determinations, 2 742.
Molecular volume, 269·5.

(To be continued).

* *Journal of the Chemical Society*, ccxlix., p. 367, 1883.

* *Journ. Chem. Soc.*, ccxlix., p. 367.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—In common no doubt with many other Fellows of the Institute of Chemistry, I have received a postcard from Mr. Wm. Thomson, the Honorary Secretary of the members of the Institute meeting at Manchester, and on their propositions I have the following comments to make :—

It appears that there are some chemists of high standing who are not members of the Institute whom the Institute desires to have on its list of Fellows. Of these there cannot be more than twenty or so. I conceive the right course to be that the Council should nominate them, and that the whole body of Fellows should vote on the nomination by means of ballotting papers. Such persons would probably refuse to be nominated were the condition numbered (2) in Mr. Thomson's letter to be insisted on.

To the second proposition in that paragraph, that existing members should have the option of becoming life-members on payment of £5 or £10, I for one consider that it would give old life-members like myself a claim on the Institute for repayment of a proportion of our life-membership outlay.

Those persons who desire to become Fellows, and who are not specially eminent in their profession, if their desire were a real one, could surely enter if the regulation regarding examination were modified as suggested in (3) of Mr. Thomson's letter. This relaxation of the rule might be temporary if it were thought expedient.—I am, &c.,

WILLIAM RAMSAY.

University College, Bristol,
January 16, 1886.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

SIR,—I have followed with great interest the discussion bearing upon the degrees of the Institute of Chemistry, and having carefully considered the object of the founding of the Institute, which was to raise the *status* of the chemist, and to give him a position equal to that conferred upon members of the other learned and scientific professions by their respective examining bodies.

I myself do not see how such an end can be obtained by admitting persons to the degrees of the Institute without examination. If this fatal policy is persisted in, it will end in diminishing the value of the degree, and render the endeavours to raise the profession of chemist, in the eyes of the public, abortive. I also think that such a step would be an act of great injustice to those members of the Institute who have obtained their degrees by examination.

I am confident that these opinions will be shared by a majority of the Members of the Institute of Chemistry.—I am, &c.,

D.

Liverpool, January 20, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
Vol. xvi., January, 1886.

Notes on the Literature of Explosives.—Prof. C. Munroe.—From the CHEMICAL NEWS.

Means of Removing Microbia from Water.—Dr. P. E. Frankland.—From the *Proceedings of Royal Society*.

Sensibility of Selenium and Sulphur Cells to Light.—Shelford Bidwell.—A paper read at the Aberdeen Meeting of the British Association.

International Exhibition of Inventions at London.—A continuation of the description of exhibits.

Nitrogen in the Soil.—From *Nature*.

Fixation of Nitrogen in Arable Soil.—H. Joulie.—An account of the experiments of M. Berthelot, described in the *Comptes Rendus* and already noticed.

Industrial Society of Mulhouse.—Session of Nov. 11, 1885.—C. Kœchlin announced that in continuation of his experiments on the oxidation of bases by tissues dyed in manganese bronze he has experimented on anthramine. This base, if treated like aniline or naphthylamine, gives merely greenish tints without interest. M. Bourcart called the attention of the committee to a crystalline sodium carbonate made at the works of Gaskell, Deacon, and Co. at Widnes, containing merely 1 mol. of water, being absolutely exempt from causticity and containing not a trace of alumina or of iron. C. Collin sent in a pamphlet by M. Lucien Benoist on fermentation in indigo vats and on the constitution of the theoretical vat. He sent in also a soluble black in competition for two prizes in the "Chemical Arts" department.

Ultramarine in the Moist Way.—M. Knapp.—From the *Journal f. Praktische Chemie*.

Qualitative Detection of the Fatty Oils in Mineral Oils.—L. Lux.—From the CHEMICAL NEWS, but originally from *Zeitschrift f. Prakt. Chemie*.

Composition and Examination of Commercial Quinine Sulphate.—M. de W. F. Koppeschaar.—Already noticed.

Artificial Colouring Matters employed in the Arts.—An announcement of a course of six lectures delivered by Prof. E. Noelting, and about to be reproduced in the *Moniteur Scientifique*, beginning with the February issue.

Patents taken in France relating to the Chemical Arts.—A list for the latter portion of October last.

Journal für Praktische Chemie.
New Series, Vol. xxxii., Part 10.

Nitrogenous Constituents of the Shoots of Pumpkins.—E. Schulze.—In the etiolated sprouts of pumpkins there are present glutamine, asparagine, leucine, tyrosine, vernine, xanthine bodies, ammoniacal salts, and nitrates. Most of these bodies are present both in the cotyledons and in the axial organs.

Contributions to the Knowledge of Fulminic Acid.—Louis Scholvien.—From a solution of sodium fulminate free fulminic acid is liberated by dilute sulphuric acid. Its existence in the free state was demonstrated by the preparation of its silver salts. Fulminic acid is unstable, and in its ethereal solution it is quickly decomposed into two acids agreeing with it in empirical composition. One of these acids, the isocyanuric, yields coloured salts with one, two, and three atoms of metal; if evaporated with hydrochloric acid it yields hydroxylamine and with potassa ammonia. It contains crystalline water, and on prolonged standing passes spontaneously into a second monobasic acid, β-isofulminuric acid, which is not affected by hydrochloric acid. The second product of decomposition, isocyanilic acid, yields unstable salts. It is not affected by hydrochloric acid, but boiling potash lye acts energetically, forming an acid isomeric with the uroxanic, which produces a deep violet potassium salt.

Action of Acetone upon Aniline.—Carl Beyer.—This paper is a reply to C. Engler and P. Riehm, who have republished some of Beyer's researches and taken up a subject the further examination of which he had reserved to himself. The editorial committee of the Berlin *Berichte*, in which Engler and Riehm's memoir had appeared, seems to have refused to insert Beyer's reply.

New Analytical Determination of Cadmium.—A. Carnot and M. Proromant.—From the *Comptes Rendus*.

Compounds of Gold Bromide with Phosphorus Bromide and Chloride.—L. Lindet.—From the *Comptes Rendus*.

Detection and Rapid Determination of Nitric Acid in Air and Water.—A. Grandval and H. Lajoux.—From *Comptes Rendus*.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxi., Part 2.

Decomposition of Chlorine Water in Sunlight.—A. Popper.—The author has, in a former paper, shown the incorrectness of the ordinary supposition, that on the decomposition of an aqueous solution of chlorine on sunlight the only products are oxygen and hypochloric acid,

and has demonstrated the existence of a chlorate in the liquid after neutralisation. He has now examined the question whether the chloric acid was formed in the decomposed chlorine water, or took its rise afterwards on evaporating the neutralised solution by the decomposition of potassium hypochlorite. He finds that chloric acid must be present prior to neutralisation and evaporation.

Remarks on the foregoing Investigation.—L. Pebal.—In this thermo-chemical paper the author expresses the opinion that the difference in the behaviour of bromine and chlorine water depends on the different stability of the products of the decomposition.

Communications from the principal Chemical Laboratory of the University of Tübingen.—These comprise papers by A. Scheufelen, on iron compounds as transferrers of bromine; and by Lothar Meyer, on ferric chloride as a transferrer of iodine.

Communications from the Chemical Laboratory of the University of Jena.—These comprise a memoir by Adolf Israel, on propio-propionic-ethyl ether; and two papers by S. W. James, the one on the action of phosphorus pentachloride upon diethyl-acetacetic ether, and on the synthesis of acetacetic ether from cyanaceton.

Experiments on the Synthesis of Substances of the Uric Series.—R. Behrend.—The author has unsuccessfully attempted to remove 1 mol. of water from the compound described as hydroxy-xanthine. This body, on treatment with phosphorus pentachloride, yields methyl-hydroxy-xanthine, which is also prepared by heating ammonia with brom-methyl-uracil. The product is amido-methyl-uracil, the hydrochlorate of which, on treatment with potassium cyanate, yields methyl-hydroxy-xanthine.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 1, January 1, 1886.

Direct Fixation of Atmospheric Nitrogen by certain Clayey Soils.—M. Berthelot.—Already noticed under the *Comptes Rendus*.

Acetophenone or Hypnone; a New Hypnotic Medicine.—S. Limousin.—A medical paper.

Hot Mineral Springs of Hamman-el-Lif, in Tunisia.—A. Barillé.—Of no chemical interest.

Falsification of Bees'-Wax.—A. Clarency.—The author first determines the specific gravity. He then boils a portion in a little water for the detection of mineral substances, starch, and turmeric. Finally he saponifies a portion with a solution of sodium carbonate for the recognition of fats, vegetable waxes, and paraffins.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiv., Part 9.

Modifications and Effects of Water in Irrigation.—Prof. J. Kōnig and Dr. Boehmer.—An account of experiments made with the waters of the Rivers Durance, L'Isle, and Meurthe. The water was applied in some cases only for a few hours annually,—from 2¾ to 38,—and in others for 1178 to 2436 hours, or 101 days.

The Signification of the Hygroscopic Moisture of the Soil for Vegetation.—Dr. E. W. Hilgard.—The view formerly accepted, that the specific absorptive power of different soils for atmospheric moisture has a decided influence upon the prosperity of their vegetation, has latterly been pronounced erroneous by Riesler, Heinrich, Ad. Mayer, and Von Liebenberg. The author considers that the method adopted by these observers is not conclusive, and he gives instances incompatible with their views. He concludes that in a space fully saturated with watery vapour the absorption rises with the temperature up to 35°, the increase following apparently an arithmetical law. In a partially saturated atmosphere the absorption regularly decreases with an increasing temperature, Knop's law for this case not being universally applicable. A little below 15° the moisture seems equally distributed between the air and the soil.

The Influence of Different Manures on the Composition of the Ash of Tobacco.—W. H. Jordan.—The composition of the ash of tobacco is essentially modified by the different manures. The conclusion is drawn that tobacco should never be manured with common salt, kainite, or potassium chloride. Potash should be given as a sulphate or a carbonate.

Sugar as Food for Cattle.—B. Lawes.—From the *Journal of the Royal Agricultural Society of England.*

Analysis of American Cattle Foods.—E. H. Jenkins.—From the *Annual Report of the Connecticut Agricultural Experimental Station.*

Composition of the Total Milk of Short-Horn Cows, and of the Milk of Single Cows and Goats of Various Races.—Dr. P. Vieth.—The author, whose observations seem to have been made in England, gives the results of the analysis of the milk of a herd of three hundred short-horn cows, as made regularly for some years. The yearly means show for total solids respectively 13·0, 13·1, and 13·0 per cent. Cows of the Jersey, Guernsey, and Ayrshire breeds give, however, a higher mean as well as higher maxima.

Studies on the Albumens of Milk.—Dr. W. Engling.—The albumen of milk, as precipitated by boiling, was found rather richer in carbon and poorer in nitrogen than it is stated by Musro and Menozzi.

The same author has examined the albumen of colostrum, which has the same composition as the albumen of the blood.

Preservation of the Germinative Power of Seeds by Exclusion of Air, and by Desiccation at High Temperatures.—Prof. Wilhelm.—Seeds retain their germinative power longer if the air has been excluded. Still more favourable is the action of drying for two hours at 50°.

Assimilation-Products of the Leaves of Angiospermous Plants.—A. Meyer.—The author examines the question what chemical processes occur during the assimilation of the carbon of the atmospheric carbonic acid by the plant cell.

Root Tubercles of the Papilionaceæ.—F. Schindler.—These tubercles are not pathological outgrowths, but belong to the normal life of the plant.

Carbonates in Living Plants.—Berthelot and André.—From the *Comptes Rendus.*

Development of the Amarantaceæ.—Berthelot and André.—From the *Comptes Rendus.*

Analysis of the Leaves and Stems of Tobacco.—E. H. Jenkins.—From the "Annual Report of the Connecticut Agricultural Experimental Station."

Composition of the Ash of Strawberries—J. M. H. Munro.—From the CHEMICAL NEWS.

Yields of the Hop-Culture.—Dr. Emil Pott.—The author maintains that the production of the largest quantity of hops and that of the finest quality are two results not capable of being united.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Tome xii., October, 1885.

Report presented by M. de Luynes on behalf or the Committee of the Chemical Arts on the Processes of Appert Bros. for the Application of Compressed Air to Glass-Blowing.—This invention effects a purely mechanical object by purely mechanical means, and cannot therefore be legitimately considered as a "chemical art."

On the Utilisation of Sulphuric Acid which has served for purifying Petroleum or the Carbides of Coal-Tar.—A translation from the *Chemiker Zeitung.*

MISCELLANEOUS.

The Redwood Testimonial Fund.—A committee has been formed for the purpose of making a public recognition of Dr. Theophilus Redwood's services to pharmacy and the sciences connected therewith on the occasion of his retirement from the Professorship of Chemistry and Pharmacy to the Pharmaceutical Society, his appointment as Emeritus Professor, and his attainment (in March next) of the age of eighty years. This will involve the collection of a considerable sum of money, and in asking for support from pharmacists, medical men, and scientific chemists, the following sketch of Professor Redwood's career is submitted to show how largely such a claim is justified by the important services rendered by him to chemistry, more especially in its relations to medicine and pharmacy. In the year 1842 (just 44 years ago) Dr. Redwood was appointed Professor of Pharmacy to the Pharmaceutical Society, and in 1844 Director of the Chemical Laboratories. In 1846 he succeeded the late Professor Fownes as Professor of Chemistry. In these several capacities, in the first instance with Fownes, Pereira, and Thomson, he laboured earnestly and with marked success to promote the cause of scientific education in pharmacy, and at the present time the majority of practising pharmacists, many medical men, and not a few scientific chemists, owe much of their early scientific knowledge to his teaching. Professor Redwood's official connection with the Chemical Society dates from the year 1852, when he was appointed Secretary in conjunction with the late Sir Benjamin Brodie, a post which he held, subsequently with Professor Odling, until 1865, when he undertook the duties of Treasurer until 1870. In 1846 the Cavendish Society was founded, with Prof. Redwood as Secretary, a post which he retained during the whole period of its existence. Prof. Redwood's association with the British Pharmacopœia began in 1854, when he acted as Secretary to the Pharmacopœia Committee, which was appointed by the Pharmaceutical Society, at the suggestion of the Royal College of Physicians. The Committee held its sittings up to 1862, working from the year 1858 in conjunction with the Medical Council. In 1865 Professor Redwood was appointed by the Medical Council to edit a new edition of the British Pharmacopœia, which appeared in 1867, the edition with Addenda which appeared in 1874, and again the recent edition of 1885. Prof. Redwood's "Supplement to the Pharmacopœia" (8vo., 1118 pp.) has long been out of print, but is a book which had a world-wide reputation as an encyclopædia of Materia Medica. The first edition appeared in 1847, the second in 1848, the third and last in 1857. In 1840 Professor Redwood published a manual of "Practical Pharmacy," founded on that of Dr. Mohr. In 1872 an abridged edition of Pereira's "Materia Medica" was published, to which Professor Redwood contributed the chemical and pharmaceutical portion. In 1841 Professor Redwood was associated with the late Mr. Jacob Bell in the foundation of the *Pharmaceutical Journal*, of which he subsequently became editor, and continued in this capacity until 1870. Its pages bear witness to the extent of his contributions to pharmacy and to the sciences on which it depends. In 1856 Professor Redwood, in conjunction with Professors Graham and Hofmann, was appointed to report to the Chairman of the Board of Inland Revenue "On the Supply of Spirit Free from Duty." This led to the exemption of "Methylated Spirit" from Government duty, and thus accelerated the progress of many branches of industry as well as of scientific research. The foregoing sketch, although it includes only the chief features in Professor Redwood's career, shows how largely he has contributed to the development of the Materia Medica, how much purely honorary work he has done for the science of chemistry, and how, for more than half a century, he has devoted himself to the promotion of the scientific sides of Pharmacy, more particularly in connection with the organisation of the Pharmaceutical Society. Cheques, &c., crossed "London and Westminster Bank, Bloomsbury Branch," should be made payable to the "Redwood Testimonial Fund," and sent to the Honorary Secretary, Professor DUNSTAN, 17, Bloomsbury Square London, W.C.

MEETINGS FOR THE WEEK.

MONDAY, 25th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Friction," by Prof. H. S. Hele Shaw.
TUESDAY, 26th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8 30.
—— Royal Institution, 3. "Naucratis," by R. Stuart Poole, LL.D.
—— Society of Arts, 8. "The Importance of a National Scheme of Emigration for the Best Interests of British Commerce," by Arnold White.
WEDNESDAY, 27th.—Society of Arts, 8. "Machinery in Mines," by Henry Davey, M.Inst.C.E.
—— Geological, 8.
THURSDAY, 28th.—Royal, 4.30.
—— London Institution 7.
—— Society of Arts, 8. "The Magnetism of Ships and the Mariner's Compass," by William Bo·tomley.
—— Royal Institution, 3. "Metals as affected by Small Quantities of Impurity," by Prof. W. Chandler Roberts-Austen, F.R.S.
FRIDAY, 29th.—Royal Institution, 9. "Capillary Attraction," by Sir William Thomson, D.C.L., LL.D., F.R.S.
SATURDAY, 30th.—Royal Institution, 3. "The History of Volcanic Action in the British Isles," by Archibald Geikie, LL.D., F.R.S.

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SELECT METHODS IN CHEMICAL ANALYSIS
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BY

WILLIAM CROOKES, F.R.S., V.P.C.S.,
EDITOR OF "THE CHEMICAL NEWS."

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THE CHEMICAL NEWS.

Vol. LIII. No. 1366.

ON THE DETERMINATION OF OXIDE OF IRON AND ALUMINA IN PHOSPHATES.

By BERNARD DYER, F.C.S., F.I.C.

The following is an accurate and satisfactory method of determining oxide of iron and alumina in phosphates:—

Two grms. of the powdered phosphate are digested in hydrochloric acid and evaporated to dryness in a water-bath, and the residue is taken up with a little more hydrochloric acid. The sand being filtered off, the filtrate, diluted to about 100 to 150 c.c., is then precipitated with a considerable excess of acetate of ammonia, *in the cold*, a slight excess of acetic acid being added. The gelatinous precipitate is allowed to subside for some time (preferably over-night), and the supernatant liquor is poured carefully off through a filter. The precipitate is then washed again by decantation with cold water, transferred to the filter, and then washed two or three times with hot water. It is then dried, burnt, and weighed.

This "acetate of ammonia precipitate," thus weighed, contains phosphoric acid, oxide of iron, alumina, and (usually) some lime.

After weighing it is dissolved in hydrochloric acid,—a very easy and rapid operation if *concentrated* acid be used—a sufficiency of citric acid is added to keep the oxide of iron and alumina in solution, the solution is neutralised with ammonia, a slight excess of acetic acid is added, and any lime present is precipitated with oxalate of ammonia, filtered off, and weighed in the usual way.

The phosphoric acid in the filtrate is then precipitated in the usual way, as ammonio-magnesian phosphate, and weighed as pyrophosphate. The ammoniacal filtrate is treated with sulphide of ammonium, and after standing a sufficient length of time the ferrous sulphide is filtered off, washed, oxidised with nitric acid, precipitated with ammonia, and the iron is weighed in the form of oxide.

The combined weight of the lime, the phosphoric acid, and the oxide of iron, being deducted from the weight of the "acetate of ammonia precipitate," the difference necessarily gives the weight of the alumina,—though of course, if it be wished, this may be directly obtained by the evaporation of the filtrate from the ferrous sulphide, its incineration, fusion with bisulphate of potash, and subsequent solution and precipitation with ammonia. This separate determination, however, of the alumina is wholly unnecessary.

In the foregoing method there is, as far as I know, no originality whatever, but I have been led to publish it by the letter which appeared in the Chemical News (vol. liii., p. 35), which seems to show, if its statements are correct, that some chemists are certainly at fault in this matter.

It is, I believe, customary with some chemists to weigh the "acetate of ammonia precipitate" and assume that it consists of a simple mixture of ferric and aluminic orthophosphates. The oxide of iron being volumetrically determined, is calculated into $Fe_2P_2O_8$, and it is then assumed that the remainder of the precipitate is $Al_2P_2O_8$, and the alumina is deduced from this assumption. As a matter of fact it is very rarely that the "acetate of ammonia precipitate" has this composition, being generally of a more basic nature; and, moreover, it is rarely that lime is absent, it being exceedingly difficult to obtain phosphates of iron and alumina free from lime when precipitating from a solution containing an overwhelming excess of this substance.

The method may appear tedious, though it is less so in practice than it appears to be on paper. It certainly entails a day longer than more rough and ready methods, but it is the only mode of procedure I am at present acquainted with that gives accurate results, and the only one that I should myself consider admissible as the basis of a certificate.

It may have been noticed that at the outset I mentioned hydrochloric acid as a solvent; and this suggests a point that may be productive, and often *is* productive, of analytical discrepancies. Certain phosphates, as is well known, contain iron pyrites. It is not fair to regard the iron in pyrites as oxide of iron; and hydrochloric acid has the advantage of not dissolving up the pyrites, but leaving it amongst the siliceous matter. The solution contains only the iron existing as oxide (or phosphate). The iron present as pyrites may be determined by igniting the sand and treating it with hydrochloric acid, in which the iron is then of course readily soluble, and may be easily determined.

But no analysis of a phosphate should include, in the term "oxide of iron," the iron that is present as pyrites.

If nitric acid be added to the original solvent the *whole* of the iron passes into solution, and is all included as "oxide," unless, of course, a separate determination of pyrites be made, and a deduction made for it.

If the pyrites is not shown separately in the analysis of a phosphate which contains it (such as the Carolina river phosphates), the statement ought to be, to avoid misunderstanding, either—

"Oxide of iron (exclusive of iron as pyrites), x·x per cent."

or—

"Oxide of iron (inclusive of iron existing as pyrites) x·x per cent."

But it is far better to state the pyrites and oxide of iron separately, that there may be no confusion.

This point is important not merely for avoiding discrepancies, but as materially affecting the apparent value of a phosphate; for iron pyrites in a phosphate is by no means the objectionable constituent that oxide of iron is.

Laboratory, 17, Great Tower Street, London, E.C.,
January 19, 1886.

DETECTION AND ESTIMATION OF THALLIUM IN PRESENCE OF LEAD.

By EMIL. A. WERNER (Dublin).

The separation of thallium from lead, and its estimation when occurring in solution with the latter metal, cannot be effected by any of the hitherto known methods without the previous separation of the lead, by precipitation as sulphate or otherwise; and, indeed, without the spectroscope the simple detection of small quantities of thallium in presence of lead is almost impossible without the previous separation of the last-mentioned metal. Having occasion to work up some laboratory residues containing thallium mixed with large quantities of lead, &c., the following method was found to work admirably, without necessitating beforehand the separation of the inexpensive lead:—

If a solution of sodic thiosulphate be added to a neutral or alkaline solution of a lead salt a white precipitate of lead thiosulphate is first formed, which dissolves on adding excess of the precipitant, a complex double salt of lead and sodium thiosulphate being probably formed, each molecule of PbS_2O_3 requiring 10 molecules of $Na_2S_2O_3$ before complete solution is effected. From such a solution lead is not precipitated by the majority of the reagents for that metal, such as sulphates, chlorides,

iodides,* &c. If a solution of sodic thiosulphate be added to a neutral solution of a thallium salt no precipitate is produced, and in such a solution containing excess of $Na_2S_2O_3$, KI produces the characteristic yellow precipitate of thallious iodide.† By taking advantage of this negative reaction of thallium, its separation from lead in a single operation is readily effected. To the liquid containing both metals in solution (if acid the solution must be carefully neutralised beforehand) sodic thiosulphate is added until the precipitate first formed is entirely re-dissolved. Potassic iodide is then added until it ceases to produce a yellow precipitate. The thallium is thereby wholly removed, and the pure metal can be readily obtained from the washed and dried precipitate by fusion with potassic cyanide.

As a qualitative test for the detection of minute traces of thallium in presence of large quantities of lead this method rivals almost the spectroscope in delicacy. By means of it, 1 part of thallium in 653,600 parts of solution, and mixed with over 5000 times its weight of lead, can be easily detected.

INSOLUBILITY OF BARIUM CHLORIDE IN PRESENCE OF LITHIUM CHLORIDE.

By CARTER N. DRAPER.

In the examination of some samples of commercial lithium carbonate for sulphuric acid, I observed that on the addition of barium chloride to the neutral solution of the chloride a considerable crystalline precipitate was formed. That a double salt might have been produced seemed, under the circumstances, to have been probable; but repeated crystallisation and examination by the spectroscope of the finally-resulting crystals showed so definitely that this was not the case that a quantitative examination became unnecessary. The crystalline precipitate is simply barium chloride insoluble in a concentrated solution of lithium chloride. The well-recognised insolubility of barium salts in concentrated inorganic acids would here appear to be intensified by the presence of a base, with the low atomicity of lithium, for a like result is obtained, though in a much less marked degree, when, instead of lithium chloride, the chlorides of sodium, potassium, or calcium are employed.

The phenomenon appears to be one of dissociation; the more soluble salt withdrawing from the less soluble the water necessary to retain it in solution.

ANALYSES OF SOME IRON ORES.

By J. CUTHBERT WELCH.

I. *Hæmatite.*

1. A stalactitic, compact specimen from Arendal, in Norway. It was of a very dark steel-grey colour, and possessed a high metallic lustre. Streak very dark brownish red. Rather brittle, yielding, when broken, a surface furrowed in one direction. Very feebly magnetic. Three determinations of its specific gravity, at 17° C., gave 5·266, 5·258, and 5·261; mean = 5·260. Metallic iron = 69·28 per cent.

Data.

Iron—
0·25 grm. required 17·32 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0163 grm. hygroscopic water.
Sulphur—
5 grms. gave 0·1165 grm. barium sulphate.
Phosphorus—
4 grms. gave 0·0023 grm. magnesium pyrophosphate.
Silica—
5 grms. gave 0·0103 grm. silica.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	98 972	99·296
H_2O (hygros.) ..	0·326	—
S	0·320	0·321
P_2O_5	0·037	0·037
SiO_2	0·206	0·207
CaO and As.. ..	traces	traces
	99·861	99·861

2. This was given to me as a fair sample of the better class of ore in the district of Penrhyn, North Wales. It varied from reddish brown to nearly black in colour, and was either botryoidal or inclining to granular in form; in the former case being rather brittle and shiny, with a submetallic lustre; in the latter hard, friable, and dull. Streak reddish brown. Fracture uneven and rough. Two determinations of its specific gravity gave 4·59 and 4·536; mean = 4·563. Metallic iron = 65·399 per cent.

Data.

Iron—
0·5 grm. required 32·7 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0658 grm. hygroscopic water.
Combined water—
5 grms. gave 0·0260 grm. combined water.
Sulphur—
5 grms. gave 0·0131 grm. barium sulphate.
Magnesia—
5 grms. gave 0·0012 grm. magnesium pyrophosphate.
Lime—
5 grms. gave 0·0517 grm. calcium sulphate.
Silica—
5 grms. gave 0·1636 grm. silica.
Arsenic—
5 grms. gave 0·0119 grm. magnesium pyroarsenate.
Alumina—
5 grms. gave 0·0163 grm. alumina.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	93·428	94·680
H_2O (hygros.) ..	1·316	—
H_2O (combined)..	0·520	0·527
S	0·036	0·037
MgO	0·008	0·008
CaO	0·426	0·432
SiO_2	3·272	3·316
As	0·115	0·117
Al_2O_3	0·326	0·330
Mn and Cu	traces	traces
	99·447	99·447

3. From Ulverstone, Cumberland. Colour ochreous-red. Earthy and friable. Streak of a rather lighter shade than the colour. Fracture subconchoidal to uneven. Finely speckled in places with a white substance which appeared to be at times quartz, at others calcite. The portion analysed was picked as free from these spots as possible. Three determinations of its specific gravity gave

* Lead iodide, being readily soluble in $Na_2S_2O_3$ solution, the addition of KI produces no change in the above solution. If, however, a solution of iodine in KI be added a precipitate of PbI_2 is formed, which at first re-dissolves on shaking, but afterwards becomes permanent, though a considerable quantity of unoxidised thiosulphate still remains in solution.

† Thallious iodide is somewhat soluble in an excess of $Na_2S_2O_3$, but in presence of a lead salt is practically insoluble.

4·638, 4·630, and 4·256; mean = 4·508. Metallic iron = 60·2 per cent.

Data.

Iron—
0·25 grm. required 15·05 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0363 grm. hygroscopic water.
Combined water—
5 grms. gave 0·0032 grm. combined water.
Sulphur—
5 grms. gave 0·2709 grm. barium sulphate.
Phosphorus—
4 grms. gave 0·0973 grm. magnesium pyrophosphate.
Lime—
5 grms. gave 0·0786 grm. calcium sulphate.
Silica—
5 grms. gave 0·4626 grm. silica.
Lead—
6 grms. gave 0·330 grm. lead sulphate.
Copper—
6 grms. gave 0·0083 grm. copper subsulphide.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	86·000	86·631
H_2O (hygros.) ..	0·726	—
H_2O (combined)..	0·064	0·065
S	0·744	0·749
P_2O_5	1·556	1·567
CaO	0·647	0·652
SiO_2	9·352	9·421
Pb..	0·376	0·379
Cu..	0·138	0·139
MgO, Al_2O_3, and TiO_2..	traces	traces
	99·603	99·603

4. A blackish brown, massive, and compact ore from Hull Just, Cornwall. Streak brownish red. Brittle, showing a coarse, uneven fracture when broken. Its specific gravity = 4·915. Metallic iron = 67·999 per cent.

Data.

Iron—
0·5 grm. required 33·5 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0138 grm. hygroscopic water.
Phosphorus—
4 grms. gave 0·0288 grm. magnesium pyrophosphate.
Lime—
5 grms. gave 0·1012 grm. calcium sulphate.
Magnesia—
5 grms. gave 0·0225 grm. magnesium pyrophosphate.
Manganese—
3 grms. gave 0·0220 grm. trimanganic tetroxide.
Silica—
5 grms. gave 0·0830 grm. silica.
Arsenic—
4 grms. gave 0·0194 grm. magnesium pyroarsenate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	95·714	95·980
H_2O (hygros.) ..	0·276	—
P_2O_5	0·461	0·462
CaO	0·833	0·835
MgO	0·162	0·163
MnO	0·062	0·062
SiO_2	1·606	1·611
As..	0·235	0·236
Pb and S	traces	traces
	99·349	99·349

(To be continued).

DETERMINATION OF SMALL QUANTITIES OF SODIUM CHLORIDE IN PRESENCE OF POTASSIUM CHLORIDE.

By F. RÖTTGER and H. PRECHT.

To determine with accuracy small proportions of sodium chloride in an excess of potassium chloride the authors first sought for a method of concentrating the sodium chloride from a large quantity of the potassium salt, so as then to be able to submit the resulting product to analysis. To this end they tried:—

1. Precipitation of potassium chloride as acid potassium tartrate.
2. Conversion of the sodium chloride into sodium hydroxide by means of potassium hydroxide and removal of the former by lixiviation with absolute alcohol.
3. Direct extraction of the sodium chloride by means of dilute alcohol.

The last method is the best; it depends on the fact that sodium chloride is more soluble in alcohol at 90 to 95 per cent than potassium chloride; 20 grms. of the mixed salts containing 0·1 grm. NaCl were covered with 40 grms. alcohol at 90 per cent, digested for half an hour, filtered, washed with alcohol of the same strength and in the filtrate, weighed after evaporation and gentle ignition; the potassium chloride was determined in the usual manner with platinum chloride, and the sodium chloride is taken as difference. It is necessary to add to the mixture of alcohol and saline mixture ½ c.c. of a 10 per cent solution of potassium carbonate in order to precipitate any magnesium chloride as carbonate.—*Berichte Chem. Gesellschaft.*

AN ABBREVIATED METHOD OF DETERMINING PHOSPHORIC ACID BY THE MOLYBDENUM PROCESS.

By M. MEINECKE.

If the well-known yellow precipitate produced on throwing down phosphoric acid with the ammonium molybdate is heated to 400° to 500° there remains molybdenum phosphomolybdate as a black residue. This compound in certain conditions is very stable, and as it is only very slightly hygroscopic it can be weighed with safety. Meinecke finds that its composition is constant (4·018 per cent P_2O_5), and proposes this process as a substitute for the magnesia one in the analysis of substances containing phosphoric acid whether in small or large proportion.

In effecting the determination the nitric solution of the phosphate obtained in the ordinary manner and containing from 20 to 25 per cent of ammonium nitrate is precipitated with molybdic solution at 50° to 60°, stirring meanwhile, and the precipitate is then set aside to settle for some hours without any further application of heat. This departure from the usual procedure is essential in order that the phosphoric and molybdic acid in the precipitate may have the fixed molecular proportion of 1 : 24. After settling for two to three hours the precipitate is collected on a filter, washed first with a faintly acid 20 per cent solution of ammonium nitrate until ten drops react neither with sulphuretted hydrogen, nor, in case of solutions rich in iron, with potassium ferrocyanide. The washing is completed with cold water, or, to expedite the drying, once with water, once with alcohol, and once with ether. The dried precipitate is detached as completely as possible from the filter and placed in the flat platinum capsule. The filter is then incinerated separately in a platinum crucible at the lowest possible temperature, the ash added to the main precipitate in the capsule, which is covered with platinum foil and placed over an "Iserlohn" (Mastes') burner with triple air current at a temperature

just sufficient for a slow decomposition indicated by the blackening of the precipitate. In one quarter hour the precipitate becomes uniformly black and may be weighed when cold.—*Repertorium Anal. Chemie* (vol. v., p. 153).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 21st, 1885.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

MESSRS. Charles Langert, W. J. Cousins, W. Watson Will, and G. H. Bailey were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Caleb Ferrey, M.B., C.M., B.Sc., Mainhead, Bondi, Sydney, N.S.W.; Francis W. Leeds, Glenfield, 69, Highbury New Park, N.; Arthur Percy Hoskins, 58, Wakehurst Road, New Wandsworth, S.W.; James Galbraith Ross, 14, Argyle Place, Grange, Edinburgh; Arthur John Starey, 8, Duncombe Road, Hornsey Rise, N.; Sidney Williamson, Fairholme, Esher, Surrey; William T. Wright, 15, Victoria Road, Bromhall Park, Sheffield; Brougham Young, Home Lyn, Woodberry Down, London.

The following papers were read :—

1. "*The Influence of Silicon on the Properties of Cast-Iron.*" Part III. By THOMAS TURNER.

The paper is a continuation of those recently published by the author on the same subject (*Trans.*, xlvii., 577, 902). It is shown that the previous results strongly support the author's conclusions, although opposite opinions have been generally held.

The Woolwich Report, "Cast-Iron Experiments, 1858," is considered in detail. This Report included the chemical analyses and mechanical tests of 70 specimens of British cast-iron. The author classifies these irons according to the amount of phosphorus present, and in different tables considers every specimen mentioned in the Report. Some of the more important results are as follows :—

1. Only eight specimens were mentioned as being "too hard to turn;" seven of these contained under 0·9 per cent of silicon, while the eighth was rich in phosphorus and sulphur. These facts strongly support the author's conclusion that a softening effect is produced by a suitable proportion of silicon.

2. The six best specimens mentioned in the Report contained on an average 1·393 per cent of silicon, while the author, from his own experiments, recommended about 1·4 per cent. The six specimens lowest in silicon are of intermediate quality, while the six specimens highest in silicon are of inferior quality. These results support the author's view that a suitable proportion of silicon is beneficial.

3. When the specimens are classified according to their proportion of phosphorus, and arranged in tables in order of silicon present, a gradual improvement is noticed as the silicon increases until a certain point is reached, beyond which point the metal deteriorates in quality. In one table, however (0·2—0·4 per cent of phosphorus), no such regularity is observed: this is due to the small variations in silicon and the large alterations in the proportion of other elements present.

4. That the maximum points are as follows :—(See Table next column).

With under 0·2 per cent phosphorus	1·88 p.c. Si
Between 0·4 and 0·6 per cent phosphorus	1·21 ,,
Between 0·6 and 1·0 per cent phosphorus	1·41 ,,
Over 1 per cent phosphorus	1·57 ,,
English irons in the Appendix	1·03 ,,
Foreign irons in the Appendix	1·33 ,,
Mean	1·405 ,,

The author also refers in detail to Sir William Fairbairn's experiments of 1853 on the influence of re-melting on the mechanical properties of cast-iron. It is shown that the results obtained may be entirely explained by the chemical changes which took place; and that when regarded in this light they illustrate the influence of silicon on cast-iron very much in the same way as did the results previously published by the author.

DISCUSSION.

Prof. UNWIN said that Mr. Turner had done a service in removing the popular prejudice that silicon is a very injurious constituent of cast-iron. This prejudice arose a long time ago, apparently from the difficulty experienced in smelting very rich iron ores containing much silica. Thus the Turkish Government in 1844 wished to utilise an exceedingly rich ore (magnetic ore containing 12 per cent silica) found at Samakoff, but could not smelt it, and the difficulty was attributed to the silica. Again, about 1853 attempts were made to improve cast-iron guns, and Mr. Cochrane advised the use of Nova Scotia iron. This was tried at Woolwich, but the Chemical Department there refused to sanction its use on the ground that it contained too much silicon, notwithstanding that Mr. Fairbairn's mechanical tests were in its favour.

Prof. UNWIN exhibited specimens of some of the bars produced in Mr. Fairbairn's 1853 experiments in the re-melting of iron, and he stated that the iron was re-melted in a brass furnace, not a cupola. From the analyses quoted of the bars tested in these experiments it appeared that the only chemical change which occurred in re-melting was the change in the amount of silicon, which therefore seemed to be the sole cause of the variation in strength. But this was a fallacy: the methods of determining carbon in those days were faulty, and no distinction was drawn between graphitic and combined carbon. The change in properties on re-melting was always attributed chiefly to the change from graphitic to combined carbon. Mr. Turner stated that he had found exceptional values of the modulus of elasticity. Now the determination of the modulus of elasticity was so difficult that hardly any measurement is to be trusted unless the measurements are made on suitable bars under suitable conditions; frequently the bars used are far too short. He was not prepared to agree that because a certain proportion of silicon was present, therefore the iron was good; and it was essential to bear in mind that in cast-iron we want not strength so much as certain working qualities; mere crushing strength was of very little importance.

As supporting Mr. Turner's views, Mr. POCHIN quoted an instance of an iron containing some amount of silicon being accepted by a manufacturer of very small castings as suitable in place of one with less which had been complained of as unsuitable on the ground that it contained too much silicon. He suggested that some of the discrepancies in analyses referred to by the author might really be due to difference in composition; different parts of one and the same pig or steel ingot often differ very much in composition. He had recently had occasion to notice great differences in quality in the two ends of steel sleepers, the one withstanding all tests, the other breaking readily.

Mr. TURNER, in reply, said that he did not contend that a large proportion of silicon was good, but that when present in suitable proportion it improved the quality of the iron. No doubt the conversion of graphitic into combined carbon was a most important change, but the extent to which this took place probably in some way depended on the amount of silicon present; he had shown in a previous paper that grey cast-iron can be made from white by addition of silicon. He did not think that the serious

discrepancies which he had called attention to could be explained in the manner suggested by Mr. Pochin.

2. "*The Chemical Action of Pure Cultivations of* Bacterium aceti." By Adrian J. Brown.

After referring to the work of Pasteur and others on acetic fermentation, the author describes his method of working and the means used for obtaining pure cultivations of *Bacterium aceti*. He then treats of the mode of growth and morphology of the organism. The different cell-forms observed agree with the drawings of *B. aceti* by Hansen and Zopf. The ferment is strictly ærobic.

After showing that *B. aceti* oxidises ethylic alcohol to acetic acid, and that the acetic acid so formed is subsequently destroyed by the ferment, its action on other alcohols of the same series is studied. Normal propylic alcohol is freely oxidised to propionic acid, but methylic alcohol is not acted upon. Isoprimary butylic alcohol and amylic alcohol are also not attacked.

The action of *B. aceti* on certain carbohydrates is then described. Dextrose is freely acted on by the ferment; no alcohol or volatile acid is formed during the fermentation, the sole product being gluconic acid, the relation of which to dextrose is exhibited in the formulæ:—

Dextrose—
$CH_2(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot COH.$

Gluconic acid—
$CH_2(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot COOH.$

Cane-sugar is unaffected by *B. aceti*, even when the organism is made to grow freely in a solution containing it. This is true also of milk-sugar and starch.

Mannitol is shown to be completely acted upon by *B. aceti*, the main product being lævulose. A small proportion of a body possessing a cupric reducing power, but no action on polarised light, is also simultaneously formed. No acid is formed, the lævulose produced not being further acted on by *B. aceti*. Lævulose prepared from inulin is also not oxidised by the ferment, thus indicating a marked difference in the constitution of dextrose and lævulose. Using Kiliani's formula for lævulose, its relation to mannitol is shown by the formulæ:—

Mannitol—
$CH_2(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH_2(OH)$

Lævulose—
$CH_2(OH)\cdot CH(OH)\cdot CO\cdot CH(OH)\cdot CH(OH)\cdot CH_2(OH).$

As mannitol may be formed from dextrose by the action of sodium amalgam, the oxidation of mannitol by *B. aceti* appears to afford a means of converting dextrose into lævulose.

Discussion.

The President remarked that the study of the effects produced by various organisms presents an enormous field for research; the results obtained by Fitz had already shown this. The experiments were also of interest as bearing on the examination of antiseptics, and pointed to the importance of ascertaining their effect upon a variety of organisms, as a given antiseptic might affect one kind and not another.

Dr. Armstrong said that Mr. Brown's results appeared to him to throw some light on the remarkable transformations undergone by the carbohydrates in plants and animals. It is well known that in some cases starch wanders from the leaves where it has been formed and is elsewhere again deposited as starch, as in the potato for example; that in the sugar-beet it becomes cane-sugar, and in the dahlia and artichoke, inulin; and that sometimes in animals it becomes milk-sugar. No clue has hitherto been obtained to these and similar changes. The conversion of mannitol into lævulose, however, indicates a possible mode of obtaining cane-sugar from starch, as it is unquestionable that a change such as that of starch into dextrose and then into mannitol takes place within the plant, and that individual cells may act upon the mannitol in the same way as *B. aceti* does, forming lævulose, which might then enter into reaction with dextrose. As regards the difference in behaviour of various carbohydrates, he thought that caution must be observed in reasoning from the formulæ ordinarily employed; probably even the simplest carbohydrates exist in solution as complex aggregates of several C_6 groups, and their behaviour much depends on the composition of these aggregates. Mr. Brown's observations were also of value as throwing light on the phenomena of fermentation. He (Dr. Armstrong) had long thought that fermentation took place in consequence of a something contained within the ferment organism attaching itself to the molecule of the fermented substance; action thereupon set in at this point of attachment, and hydrolysis taking place the molecule was ultimately broken up: the function of ferments was, in fact, to localise the action, whether of water alone, or of water and atmospheric oxygen. Mr. Brown's observations on mannitol clearly proved that the organism exercised a selective influence.

3. "*A Method of Separating and Estimating Zirconium.*" By G. H. Bailey, D.Sc., Ph.D.

When a solution of zirconia in dilute sulphuric acid is treated with excess of hydrogen peroxide, a white bulky precipitate is obtained consisting of an oxide of zirconium of the formula Zr_2O_5. This oxide seems to be possessed of very well-defined characters, and moreover the precipitation is a complete one. It is suggested that the reaction may be utilised as a means of obtaining pure compounds of zirconium, of separating zirconium—especially where it occurs in small quantities in minerals, and in quantitatively determining this element.

4. "*Notes on an Analysis of Koppite.*" By G. H. Bailey, D.Sc., Ph.D.

The following are the author's results:—

		Knop and Rammelsberg.
Nb_2O_5	61·4	62·18
TiO_2	0·72	—
ThO_2	—	3·0
ZrO_2	3·39	—
Ce, La, Di oxides ..	6·89	6·69
FeO	3·01	1·80
CaO	16·61	16·00
MgO	1·62	0·4
Na	3·58	5·58
K	0·36	4·23
F	Not estimated	6·23

Discussion.

The President enquired how the titanium had been separated from niobium; he was not aware that any method had yet been devised. The discovery of titanium in the mineral was in itself an interesting fact; had the author taken the precaution of excluding Dysanalyte?

Dr. Bailey, in reply, said that the titanium was estimated in presence of the niobium by a colorimetric method, by means of hydrogen peroxide; the crystals were very carefully selected, and only the octahedral ones were analysed.

5. "*The Monobromophthalic Acids.*" By G. Stallard.

Guareschi and Meldola have both assumed that the bromophthalic acid melting at 175° is the 1 : 2 : 4 modification, attributing the alternative formula—

COOH : COOH : Br = 1 : 2 : 3

to the acid melting at 139°. Guareschi obtained the acid of higher melting point by oxidising the bromonitronaphthalene produced on brominating nitronaphthalene. The author, however, finds that α-bromonaphthalene is produced on eliminating the NO_2 group from Guareschi's bromonitronaphthalene; and that it yields γ-dibromonaphthalene (melting at 130°) on displacing the NO_2 group by Br. Hence he infers that the bromophthalic acid melting at 175° is the 1 : 2 : 3 modification; and he points out that this view is favoured by the fact that,

according to Krüger, the melting-point of the anhydride of the 1 : 2 : 3 chlorophthalic acid is much higher than that of the 1 : 2 : 4 modification. This conclusion, however, does not harmonise with Meldola's view of the constitution of the dibromonaphthylamine which he obtained from bromo-β-naphthylamine from Liebermann's bromonitronaphthalene.

6. "*Benzoylacetic Acid and some of its Derivatives.*" Part IV. By W. H. PERKIN, Jun., Ph.D., and A. CALMAN, Ph.D.

In the hope that methylic benzoylacetate might prove to be a crystalline substance, the authors have prepared it from methylic phenylpropiolate and sulphuric acid; but they could not obtain it otherwise than as an oil, and several of its derivatives were also found to be oils.

Ethylic methylbenzoylacetate is described. PCl_5 converts it into ethylic α-methyl-β-chlorocinnamate,—

$$C_6H_5{\cdot}CCl : CMe{\cdot}COOEt.$$

By the action of sodium amalgam on its alcoholic solution, α-methyl-β-hydroxyphenylpropionic acid is produced. Ethylic propylbenzoylacetate is next considered, and its conversion into butylphenylketone by the action of dilute alcoholic potash is described; it yields ethylic α-propyl-β-chlorocinnamate on treatment with PCl_5. An account of ethylic isopropylbenzoylacetate and isobutylbenzoylacetate and of the corresponding ketones is then given.

The authors have further studied ethylic furfurandicarboxylate obtained by heating ethylic dibenzoylsuccinate with sulphuric acid.

7. "*Mercury Sulphites and the Constitution of Sulphites.*" By EDWARD DIVERS, M.D., F.R.S., and TETSUKICHI SHIMIDZU, M.E.

In formation, composition, and reactions the mercury sulphites, according to the authors, are not ordinary salts, and supply many facts serving for the determination of the constitution of non-saturated oxygenous salts. The mercuric radicle, Hg, takes up and preserves a non-oxylic relation to sulphuryl with an energy comparable to that it exerts in its cyanide and iodide; this is the central conception in the chemistry of the mercury sulphites, and they are of opinion that without it all the peculiarities of these salts stand unexplained.

The paper is of great length; the salts which are described and discussed, and the formulæ attributed to them, are as follows:—

Mercuric sodium sulphite .. $Hg\langle^{SO_2{\cdot}ONa}_{SO_2{\cdot}ONa}\rangle{\cdot}OH_2$

Mercuric hydrogen sulphite (known only in solution) $Hg\langle^{SO_2{\cdot}OH}_{SO_2{\cdot}OH}$

Mercuric oxysulphite.. .. $Hg\langle^{SO_2{\cdot}OHgO}_{SO_2{\cdot}OHgO}\rangle Hg{\cdot}OH_2$

Mercuric mercurous or mercurosic sulphite .. .. $Hg\langle^{SO_2{\cdot}O}_{SO_2{\cdot}O}\rangle Hg_2{\cdot}4OH_2$

Mercuric hypomercurous or hypomercurosic sulphite $Hg\langle^{SO_2{\cdot}O}_{SO_2{\cdot}O}\rangle Hg_3{\cdot}OH_2$

Only the first and third of these have been previously described. Normal mercuric and mercurous sulphites do not appear to be capable of existing.

Among the conclusions arrived at are the following:—In reduction by sulphurous acid, the acid is not as such or directly oxidised by the metallic salts reduced, but a sulphite is formed through changes in which reduction afterwards follows. Either, as in the case of mercurosic sulphite, a further quantity of the sulphurous acid or alkali sulphite resolves the salt into a double salt of part of the metal: the free metal, *e.g.*, mercurosic sulphite becomes mercuric hydrogen sulphite and mercury; or the sulphite suffers hydrolysis into metal and sulphuric acid.

Mercury and silver sulphites resemble organic sulphites (sulphonates) in undergoing hydrolysis into sulphuric acid and basic radicle, and in not oxidising in the air. The contrast they afford in this respect to most other metallic sulphites is good evidence of sulphites having a hemihaloid constitution. Hydrolysis may in fact serve as a test of the constitution of an oxygenous salt: if the salt suffer hydrolysis into acid and metal the salt is partly haloid; while if it yield acid and basic oxide it is wholly oxylic.

Sulphites are like haloid salts and unlike oxylic salts in the property which some of them display of parting with some of their chlorous radicle. Mercuric sulphite becomes mercurosic sulphite, much as manganic chloride becomes manganous chloride and cupric iodide or cyanide becomes cuprous; mercury and silver sulphites become metal and acid radicle, much as gold chlorides become gold and chlorine. There is a difference in the cases, but this is accounted for by the sulphites being hemi-oxylic salts,—therefore requiring water to effect their decomposition. Sulphites are also like haloid salts in the considerable insolubility of their silver and mercury compounds in nitric acid; and they resemble iodides and cyanides, inasmuch as the double mercury and silver salts are stable and not decomposed by free alkalies.

8. "*Potassium Chlorate.*" By FRANK L. TEED, D.Sc.

The author in a previous paper arrived at the conclusion that the decomposition of potassium chlorate by heat may be represented by the equation—

$$10KClO_3 = 6KClO_4 + 4KCl + 3O_2.$$

He has continued his experiments, and finds that when the salt is very gently heated the decomposition more nearly approximates to that indicated by the equation $22KClO_3 = 14KClO_4 + 8KCl + 5O_2$, the majority of his results falling within the limits calculated from these two equations.

As bearing on the subject, the decomposition of potassium perchlorate by heat was investigated; it appears that in the earlier stages potassium chlorate is formed, but this disappears again long before the complete decomposition of the perchlorate is effected.

He finds that when the perchlorate is heated with manganese binoxide, it decomposes apparently without any chlorate being formed.

Some numbers obtained by Baudrimont, which had an apparent similarity to his own, are criticised, and it is pointed out that Baudrimont's methods of analysis must have been untrustworthy.

The author intends continuing his experiments.

DISCUSSION.

Dr. PERCY FRANKLAND said that experiments made in the South Kensington Laboratory had given results in accordance with the equation—

$$8KClO_3 = 2O_2 + 5KClO_4 + 3KCl.$$

Care had been taken to prevent mechanical loss by placing a glass-wool plug above the chlorate; the decomposition had been effected at a known constant temperature; and the amount of residual chlorate had been determined.

Dr. ARMSTRONG remarked that the results now brought forward made it more than ever probable that, as he had previously suggested, the perchlorate simultaneously underwent decomposition even at a temperature below that at which it decomposes when heated alone: a considerable amount of heat is developed in the decomposition of potassium chlorate, and it was therefore to be expected that the amount of perchlorate formed would be less, and the amount decomposed greater, and hence that more oxygen would be obtained, when the decomposition was effected more rapidly, as the temperature would be locally higher.

Dr. TEED said that the results quoted by Dr. Percy Frankland confirmed his statement that the ratio of oxygen to chloride depends on the way in which the decomposition is effected; Dr. Frankland would find less oxygen produced at a lower temperature.

9. "*On the Sugars of some Cereals and of Germinate Grain.*" By C. O'SULLIVAN, F.R.S.

My attention has been called to a paper by Kjeldahl, of the Carlesberg Laboratory, Copenhagen, published in the *Transactions* of that Institution, in which this subject is treated. The methods employed are pretty much the same as those described by me, and the results obtained are practically confirmed by my work. Priority of publication of the chief points belongs, therefore, to Kjeldahl.

I regret very much that I should have missed this work of Kjeldahl, and I take the earliest opportunity of putting the matter right as far as I can. I may, however, say, in justice to myself, that there is sufficient novelty in the mode of treatment and in the details of my work to justify the publication of it even though I had seen Kjeldahl's paper.

10. "*Note on the Chemical Formula for Wool Keratine.*" By R. Lloyd Whiteley, Lecturer on Dyeing at University College, Nottingham.

Having occasion to calculate the approximate formula for the keratine found in wool fibre, according to "Bowman's Analyses" (p. 170, "Structure of the Wool Fibre," by F. H. Bowman), I was surprised to find what a different result I obtained from that given by Mills and Takamine (*Chem. Soc. Trans.*, 1883, xliii., 142), and quoted by Bowman. I therefore referred to Mills's data to ascertain wherein the difference lay, and found that in "Gmelin's Handbook," xviii., 351, from which the numbers had been obtained, there was an evident misprint, the values of the hydrogen and nitrogen in the percentage numbers being interchanged. This was confirmed on reference to two of the original papers, viz., Märcker and Schulze (*Annalen*, xl., 193—207), and Scherer (*Ann. Pharm.*, xl., 53).

Instead, therefore, of the formula $C_{42}H_{157}N_5SO_{15}$, as given by Mills (*loc. cit.*), the corrected results yield the formula $C_{41}H_{71}N_{12}SO_{14}$, obtained from the mean figures C 49·96, H 7·11, N 16·65, O 3·39, S 22·89 (by difference), in which probably the nitrogen is too low, and the oxygen correspondingly high.

Taking Dr. Bowman's later analyses we obtain the approximate formula $C_{43}H_{71}N_{13}SO_{13}$, from the mean figures C 50·27, H 7·05, N 18·37, S 2·90, O 20·40.

These figures are not quite free from objection, the carbon being probably rather h gh but considering the difficulty of completely purifiying the fibre from every trace of mechanically adhering mineral matter, it is probable that either of the two formulæ may be taken as closely resembling the true empirical one. This would apply to wool only, for though the analysis of other keratines, such as those of hair, horn, &c., closely agree in the amount of carbon and hydrogen, and fairly well in the amount of nitrogen, in the case of sulphur and oxygen they are proportionably much more divergent, so that it is impossible to represent them by any one formula.

11. "*Some Derivatives of Thiourea.*" By George McGowan, Ph.D., F.R.S.E.

In continuation of his examination of the derivatives of methylsulphonic acid (*J. Prakt. Chem.*, 1884, xxx., 280), the author has submitted thiourea to the action of trichloromethylsulphonic chloride. If the chloride,—

$$CCl_3 \cdot SO_2Cl,$$

be added to a cold aqueous solution of thiourea, no reaction takes place until after long standing, but on applying heat the chloride gradually dissolves, sulphur being deposited. On adding the chloride to a cold or nearly cold solution of thiourea in 80 or 90 per cent alcohol much heat is developed, and a mass of needle-like crystals separate out, the quantity being much increased by the subsequent addition of ether. The product is identical with the *dithiourea dichloride*, $(CSN_2H_4)_2Cl_2$, obtained by Claus by acting on thiourea with chlorine (*Annalen*, clxxix., 139). The same compound is obtained by the action of thiourea on mono- and di-chloromethylsulphonic chlorides and of phosphorus oxychloride, but the author failed to obtain it with acetyl chloride. When allowed to crystallise out from 90 per cent alcohol on a microscopic slide it forms highly characteristic, apparently monoclinic plates. It cannot be re-crystallised from water or alcohol, as the solutions invariably deposit sulphur. An aqueous solution strongly acidified with chlorhydric acid may, however, even be heated with impunity. It is perfectly stable at ordinary temperatures.

If dilute nitric acid be added to a moderately concentrated aqueous solution of the dichloride, a crystalline precipitate is produced in the form of jagged daggers or long sword-like plates, consisting of the nitrate—

$$(CSN_2H_4)_2(NO_3)_2.$$

These crystals were also observed to be formed in the mother-liquor from the preparation of thiourea nitrate, CSN_2H_4,HNO_3. The salt is almost insoluble in dilute nitric acid; more soluble, although sparingly, in water; practically insoluble in cold absolute alcohol and in ether. This is a comparatively stable compound, and in this respect differs from the thiourea nitrate described by Reynolds; but the author suggests that the instability of the latter may have been due to the presence of a small quantity of free nitric acid. A solution of potassium nitrate also produces a precipitate of the above nitrate in a cold aqueous solution of dithiourea dichloride.

If iodine chloride or trichloride be added to a cold alcolic solution of thiourea, dithiourea dichloride is formed, iodine separating. If potassium iodide and thiourea dichloride be suspended together in absolute alcohol they react to form urea, potassium chloride, and iodine. *Dithiourea diiodide*, $(CSN_2H_4)_2I_2$, can, however, be prepared by rubbing together in a mortar *pure* thiourea and iodine in the proportion of their molecular weights, sufficient alcohol being added to make a pasty mass; the reaction succeeds best when only small quantities are used. Once it is prepared the diiodide is quite stable, and can be preserved in a dry tube; it crystallises in long colourless prisms. It is at once decomposed by water, alcohol, and ether, iodine separating, but not by benzene. On heating the aqueous solution, or on addition of caustic alkali, sulphur separates, this separation of sulphur being characteristic of the dithiourea salts. Addition of dilute chlorhydric acid does not cau e the separation of iodine in the cold, but on heating the solution iodine is freely liberated, but no sulphur is precipitated: hence it is more easily decomposed under these conditions into iodine and thiourea than into sulphur, hydrogen iodide, thiourea and cyanamide (or derivatives thereof), these latter being the products which should result, according to Claus's observations on the dichloride.

The results are given of the complete analyses of the salts described in the paper.

At the meeting on February 4th, Dr. Klein, F.R.S., will deliver a lecture on "Methods of Bacteriological Research from a Biologist's point of view."

PHYSICAL SOCIETY.

January 23rd, 1886.

Prof. Guthrie, President, in the Chair.

The following communications were read:—

"*A Note on the Paper by Prof. W. Ramsay and Dr. S. Young 'On Some Thermodynamical Relations.'*" By Prof. W. E. Ayrton and Prof. John Perry.

The authors, after referring in the highest terms to the careful experimental work of Messrs. Ramsay and Young in their investigation upon "Some Thermodynamical Relations," the results of which were communicated to the Society at its last meeting, show that the four laws stated in their paper are in reality only one, since if any one of them is assumed the remaining three may be deduced from it. Hence it is sufficient to examine only one, and of the four the third is in the form that can be most

readily tested. This law, the statement of which is that for all substances at any given pressure the product $t\frac{dp}{dt}$ is constant, p being the pressure and t the absolute temperature of saturated vapour at that pressure, is represented mathematically thus:—

$$t\frac{dp}{dt}=\phi(p) \quad . \quad . \quad (1),$$

$\phi(p)$ being a function of the pressure, independent of the substance. Writing this equation—

$$\frac{dp}{\phi(p)}=\frac{dt}{t}$$

and integrating, we get—

$$t=a\psi(p) \quad . \quad . \quad (2).$$

$\psi(p)$ being also a function of the pressure only, and a a constant depending only upon the substance employed. It is in this form that the authors have examined the third law: if true, it follows at once (from 2) that the ratio of the temperatures of two saturated vapours to one another at any pressure is the same as the ratio at any other pressure. It is seen, however, either by reference to Regnault's numbers, or Rankine's formula,—

$$\log. p=\alpha-\frac{\beta}{t}-\frac{\gamma}{t^2} \quad . \quad . \quad .$$

an expression based upon his molecular theory, and which, as remarked by one of the authors at the last meeting, agrees with Regnault's results with remarkable closeness, that this ratio is far from constant. The authors are therefore compelled to conclude that the expressions given by Prof. Ramsay and Dr. Young must not be regarded as absolute laws.

"*A Note on the Paper by Prof. J. W. Clarke, 'On the Determination of the Heat-capacity of a Thermometer.'*" By A. W. Clayden.

The author has applied a correction to an expression given by the late Prof. J. W. Clarke for measuring the heat-capacity of a thermometer, in a paper communicated to the Society at a previous meeting (April 25th, 1885). Prof. Clarke's expression was affected by the mercury not entirely filling the bulb and stem of the thermometer. The corrected expression obtained by the author is—

$$V_1=\frac{V(S-S_2)}{S_1-\frac{S_2(1+\beta t)}{1+\alpha t}}$$

S, S_1, and S_2 being the mean densities of the instrument, mercury and glass respectively; β and α the coefficients of voluminal expansion of mercury and glass; V and V_1 the volumes of the instrument and of the mercury.

"*Note on some Organic Substances of High Refractive Power.*" By H. C. Madan.

In the course of some correspondence respecting M. Bertrand's polarising prisms, the author was informed that the cement used was naphthyl-phenyl-ketone dibromide. He has consequently prepared specimens of the ketone, and subjected them to optical examination. The ketone is a thick yellow oil, boiling at a temperature near the boiling-point of mercury; it appears to be a very stable, neutral, and harmless substance, like Canada balsam, but unfortunately it does not appear to be capable of hardening, and hence is not by itself adapted for a cement. Its refractive index for the D line is 1·666, higher than that of carbonic sulphide, while its dispersive power is approximately the same as that of that substance. The author has made the bromide of the ketone referred to above, but it seems liable to decompose, with formation of hydrobromic acid, which acts upon the spar. Mr. Madan also exhibited a specimen of metacinnamene, a highly refracting glass-like solid, obtained by the action of light or heat upon cinnamene. This substance possesses a refractive index of 1·593 for the D line, and would make a valuable cement if it showed a firm adhesiveness for glass.

The President exhibited and described an instrument he had made in the course of an acoustical investigation upon which he had been engaged. It is a musical instrument, similar in principle to the harmonicon. In the case of the harmonicon the rectangular plate is usually supported by strings passing through the nodes, but the author wished to make an instrument that could be "bowed." The "nodes" are not absolute positions of rest, the particles at them describing curves having cusps pointing outwards. The plan adopted was to solder two springs to the plate, which was of brass, the points of attachment being slightly outside the nodes, and the springs being such as to give the same fundamental note as the plate. The other ends of the springs were attached to the mouth of a resonator whose fundamental note was also that of the plate. The plate when struck or bowed gave a tone very like that of a tuning-fork; and in a discussion that followed Prof. S. P. Thompson suggested the possible use of these instruments as a substitute for a series of forks, the cost of a complete set of which often places them beyond the reach of the student.

Prof. M'Leod suggested that the springs should be tuned to the octave of the plate instead of to its fundamental, and that they should have a slightly different form.

NOTICES OF BOOKS.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by James Braithwaite, M.D. Vol. XCII., July to December, 1885. London: Simpkin, Marshall, and Co.

Among the more noteworthy papers in this summary of medical progress is one by Prof. Kônig, of Göttingen, on the disinfection of rooms. He fumigates with corrosive sublimate, and afterwards with sulphur. The results have been found satisfactory in practice. There is the additional advantage that bugs and flies, which may now be recognised as *colporteurs* of infectious disease, are exterminated. The subsequent treatment with sulphur prevents any mischief resulting from mercurial vapours. From 50 to 60 grms. of mercuric chloride is a sufficient dose.

Surgeon-Major Pringle, M.D., of the Bengal Army, communicates an important paper on Asiatic cholera. He considers sanitary cordons, and the disinfection of travellers and their luggage, as useless in practice. He would not, however, allow passengers and luggage to land from a ship which has true cases of cholera on board. The period of incubation of the infection he estimates as, on the outside, seventy-two hours. He holds that cholera is neither contagious nor infectious in the sense in which these terms are applied to smallpox and eruptive fevers generally.

Actinomycosis is an instance, more curious than pleasant, of a disease due to a fungus. The little masses of mycelium may be recognised by the naked eye as sulphur-coloured bodies about the size of a hemp-seed.

Dr. G. Oliver, in a paper on the "Clinical study of the Liver viewed through the Urine," points out that the detection of bile acids by the direct application of Pettenkofer's test to urine is practically impossible, even when present in considerable amount. He runs albuminous urine, acidified with acetic acid, over a jaundiced urine. Along the plane of contact of the two urines a sharply-defined white band of precipitated albumen will appear.

Means of Destroying Mice.—Dr. Crampe.—Wheat poisoned with strychnine is the most efficient agent. The great objection to poisons is that if the mice die in the open field they may occasion the death of owls and other mice-destroyers.

CORRESPONDENCE.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Will you allow me to give a report of a meeting of members which took place at the rooms of the Chemical Club of Manchester, on Wednesday last, the 20th inst., with a view of further discussing the Resolutions which were adopted at the previous meeting, and of taking such steps as they might consider advisable for giving effect in the Council to the feeling of the majority of the members in these matters.

The following members were added to the Committee *pro tem.*:—

R. F. Carpenter	W. Douglas Herman
George E. Davis	Charles O'Neill.
Thomas Fairley	

The following Resolutions were carried unanimously. For the sake of reference I have numbered them consecutively with those published in the Chemical News (vol. liii., p. 34):—

6. That Resolution No. 3 of last meeting be extended to read as follows:—

   That this meeting considers it desirable that the existing regulation of the Council, to the effect that a candidate for the Associateship must have studied three years in one of a limited number of specified colleges, should be extended, so as to allow such candidate to present himself for examination provided he has studied and practised for at least three years in the laboratory of a Fellow of the Institute in actual practice. *Provided that during that term or at some time previous to his presenting himself for examination he has attended thorough courses of instruction in Theoretical Chemistry, Physics, and Mathematics, and that the examinations for the Associateship should include the subjects of Physics, Mathematics, and the general subjects of English education (as well as Practical Chemistry), unless the candidate presents certificates of having passed sufficiently advanced examinations in those subjects.*

7. That this meeting feels that there ought to be a greater number of provincial members in the Council, to represent the provincial members, than is at present the case.

8. That it is desirable that provision should be made for General Meetings of the Institute in provincial towns, and that the Annual Meetings be held alternately in London and in one of the towns in the provinces.

9. That the Resolutions passed at both the meetings of Fellows at Manchester be presented to the President and Council of the Institute.

I may say that up to the present I have received replies from sixty-four members who practically agree with the Resolutions passed at the first meeting. I have also received some letters from members, who, as far as I could judge, practically agree with the Resolutions, but who expressed dissent in such a way that I could not add their names to the above list.

Sixteen members refused to give any opinion, whilst only six members expressed decided objection to any or all of the Resolutions.

I have received replies from about 100 members out of 360 living in London or in the country, and we shall be glad if any of those members who have not yet replied will be kind enough to do so, that the Committee may have before them a still larger representation of the views of the members on the important questions mentioned in the Resolutions.

The object of the Manchester Committee is to aid the Council in making the Institute more efficient and valuable to its members, and with this end in view they ask the opinions of all the Members and Associates on the questions given in the above Resolutions or in those already published.

I understand that the Council have themselves suggested the reduction of the annual subscription. With reference to Resolution No. 1 the Manchester Committee feel that the members should try to get all chemists of standing who are not at present members to join the Institute: there are, of course, some who for various reasons will not join, and these will no doubt prove a source of weakness to the Institute; but we think if the large majority of members will do their duty to the Institute, and consequently to themselves, there will be comparatively few who will prefer to remain outside. We think, however, that those chemists of standing who refused to aid, either with moral or pecuniary support, the founders of the Institute, should only be permitted now to join by paying a considerable entrance-fee, as it cannot be considered just that they should reap the benefits which have been bought by the money subscribed by those who have gone on adding to the funds during the last 8½ years, the policy hitherto having been mainly one of waiting and collecting money for future operations.

The questions involved in Resolution 3 are those which I understand meet with the greatest opposition in the present Council. Some of those who oppose Resolution No. 3 do so on the ground that examination does not test the ability or knowledge of a candidate. To this we reply, you cannot accurately estimate the value of men by examination, but stringent examinations by different examiners would show that the candidate is up to some fixed standard so far as knowledge is concerned. The next objection is that it will foster "cramming": the objectors propose that the compulsory attendance at certain specified schools or colleges, and the passing of an examination which presumably might be passed by a moderate amount of "cramming," is the better method. There would by the latter be many candidates who would learn next to nothing at the specified schools or colleges, and would ultimately undergo the process of cramming to pass the examination. Whilst necessarily these would grow up chemists outside the Institute, who would be better men in every way than the average Fellow of it, and who would soon prove that it was no discredit to be an outsider. Again, it would prove a hardship to many men endowed with the qualities of brain which make the best chemists, who are too poor, or for other reasons cannot leave the town in which they were born, to study in one of the specified colleges, but who might make rapid progress in his studies under one of the Fellows of the Institute. We do not undervalue the great advantages of a regular collegiate training, which everyone would doubtless obtain who could, but we think the Council should arrange for the entrance of Associates on a broader basis than that which they have laid down, and that the degree of the Institute be of the same nature as those of the London University, no special questions being asked of the candidate from where he obtained his knowledge, provided he possesses it.

In conclusion I may mention, in reference to resolution 7, that there are at present about 167 London, 194 Provincial, and 30 Foreign Fellows, and 43 London, 49 Provincial, and 8 Foreign Associates in the Institute; and there are 26 London Members of Council to represent 210 London Fellows and Associates, and 10 Provincial Members of Council to represent 243 Provincial Fellows and Associates. By London Members I include those who reside at Woolwich, or within a similar distance from the centre of London; and whilst no objection could be taken to any of the eminent chemists who at present form the Council, we think a better representation of the views of the majority would be given by a more equal distribu-

tion of seats on the Council in London and in the provinces.—I am, &c,

William Thomson,
Hon Sec. pro tem.

Royal Institution Laboratory,
Manchester, January, 26, 1886.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—In your last issue Prof. Ramsay considers that a reduction of life fee to Fellows of the old Institute would give original life-members a claim for repayment. At first sight his objection to the proposed rule seems tenable; but it must be remembered that old "lifers" have had no annual contribution to pay, and that many members, like myself, have since their election paid, as annual subscriptions, a sum of money equal to the amount of a life subscription, and it would be therefore no hardship to old "lifers" if those annual fees were to be taken into account.

I think myself that it would be no more than fair that Fellows of the old Institute should be allowed to become life-members of the new Institute, with a reduction of fee depending upon the amount of their annual subscriptions already paid.—I am, &c.,

P.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 1, January 4, 1886.

Researches on Antimony Sulphide.—M. Berthelot.—The author investigates here the formation-heat of antimony sulphide and that of antimony chlorosulphide. He also describes sulphantimony hydrosulphate, chlorantimony hydrochlorate, and the sulphantimonites of the sulphites.

The "Emetics" of Tellurium.—Daniel Klein.—Berzelius found that no definite isolable compound is formed on dissolving tellurous hydrate in a solution of potassium bitartrate. The author has succeeded in preparing some tartro-tellurous emetics, by setting out from the tellurites of the alkaline metals and treating them with a certain proportion of tartaric acid. In an analogous manner he has formed the double citrate of potassium and tellurous acid. He has thus formed and examined the tartro-tellurites of potassium and of sodium, the tartro-tellurite of lithium, and the citro-tellurite of potassium.

Transformation of the Oil of Turpentine into Active Terpilene.—MM. Bouchardat and J. Lafont.—The oil of turpentine has been transformed into a carbide of properties closely bordering upon those of the oil of citron,—a lævo-rotatory terpilene the deflecting power of which for yellow light is close upon $-65°$. Citrene is dextro-rotatory, $=+104{\cdot}9°$. This carbide, $C_{20}H_{16}$, occupies in the series of bivalent terpilenic carbides a place parallel to that occupied by the active camphenes in the isomeric series of monovalent camphenic carbides.

Use of Metallic Oxides for detecting Coal-Tar Colours in Wines.—P. Cazeneuve.—This paper will be inserted in full.

Poisonous Action of Alkaline Salts.—Charles Richet.—The author finds that among substances chemically analogous, such as the alkaline salts, the fatal dose is approximately equal if we consider not the absolute weight but the molecular weight of the substances. In absolute weights the metals are the less poisonous as their atomic weight is higher, which is precisely the inverse of Rabuteau's law. For equal molecules the metals whose atomic weight is the highest are also rather more poisonous. The chlorides are in absolute weight more poisonous than the bromides, and the bromides more than the iodides. But for equal molecular weights the inverse order is observed, the chlorides being a little less poisonous than the bromides and the bromides less than the iodides.

No. 2, Jan. 11, 1886.

Multiple Conditions of Antimony Sulphide.—M. Berthelot.—The transformation of the black sulphide into the orange sulphide gives thermic effects which are very feeble or altogether null. Such sulphides, having a low formation-heat, retain up to a certain point the lustre and the various characters of the bodies whence they are derived. We may remark the great difference which exists between the formation-heat of antimony sulphide and those of antimony chloride and oxide.

Reciprocal Actions and the Equilibria between Hydrochloric Acid, Hydrogen Sulphide, and the Salts of Antimony.—M. Berthelot.—Inverse actions are produced in cases where the sign of the heat evolved by the reaction of two bodies, such as antimony sulphide and hydrogen chloride, is changed by the combination of one of them with a third body, such as the water which forms hydrates, or even with one of the products of the reaction. The chemical action is not reversed abruptly, but according to a gradation of intermediate compounds, such as hydrates, hydrosulphates, hydrochlorates, oxychlorides, chlorosulphides, &c., compounds whose special formation-heat intervenes in the phenomena and tends to fill up the thermic interval between the principal reactions, These secondary compounds, for the most part, exist merely in a state of partial dissociation, that is to say, of tension of their compounds. These compounds determine and regulate the chemical equilibria between the antagonistic bodies.

Variations of Absorption-Spectra and of Emission-Spectra by the Phosphorescence of one and the same Substance.—H. Becquerel.—This memoir will be inserted at some length.

Hydrates of Hypophosphoric Acid.—A. Joly.—The author describes the tetrahydrate. He considers that hypophosphoric acid is as clearly defined by its crystalline hydrates as the phosphoric and phosphorous acids, and it equals them in stability.

Solubility of Copper Sulphate in presence of Ammonium Sulphate.—R. Engel.—Increasing quantities of ammonium sulphate precipitate copper sulphate as a double salt. If we leave a double sulphate at 0° in a saturated solution of ammonium sulphate for some days the liquid remains colourless or takes a blue tint scarcely visible.

On Certain Compounds of Acetamide with Metallic Chlorides.—G. André.—An account of the combinations of acetamide with cupric chloride, cadmium chloride, mercuric chloride, and nickel and cobalt chlorides.

On Iodaldehyd.—P. Chantard.—Iodaldehyd is a limpid, oily liquid, volatile, not inflammable, colourless, but blackening rapidly in the light. It is decomposed at 80°, and cannot be distilled unchanged, even at the pressure of 0·22 metre. It does not solidify at 20°. Its vapours attack the eyes and the respiratory organs so severely that it can be manipulated only in the open air. Its density is 2·14. It dissolves in all proportions in alcohol, ether, benzol, chloroform, and carbon disulphide. With ammonia it yields, at the ordinary temperature, the different terms of the series of oxaldines, according to the proportions.

Bulletin de la Société Chimique de Paris.
Vol. xliv., No. 12, Dec. 20, 1885.

Memoir on the Alkaline Hydrates.—E. J. Maumené.—The author maintains that the potassium, sodium, barium, and strontium hydroxides have not one single formula; they have never, and cannot have, the classical formula MO.HO (old notation). All the other hydrates of oxides are in the same case; the rule applies to all hydrates without exception, those of acids, salts, and so-called organic compounds. All bodies capable of hydratation present a series of calculable hydrates. Thus we have for potassa—

$(KO)_9\ (HO)_{47}$ up to 400°.
$(KO)_9\ (HO)_{47/3}$ from 400° up to 650° or 700°.
$(KO)_9\ (HO)_{47/7}$ from 650° or 700° up to about 1000°.

Experiments on the Fatty Bodies.—C. Dubois and L. Padé.—The authors give a table of the solubility of fats in different solvents at 12°. They have then examined the solubility of mixtures of fatty acids, and find that the solubility of the fatty acids of butter is reduced by 1·24 per cent by an addition of 5 per cent of the fat of veal.

Combustion-Heat of Certain Amines.—A. Müller.—The author finds that the affinity of R for nitrogen increases with the complication of the radicle. According to J. Thomson's formula, on the contrary, the affinity of every monatomic alcohol radicle for hydrogen is represented by the constant number 14·57 cal.

On Acid Magenta in Wines.—P. Cazeneuve.—Already noticed.

On a New Method of taking the Melting-point and Solidification-point especially of Neutral Fatty Bodies and of their Acids, but applicable also for the same purpose to all Substances which behave in an Analogous Manner with Heat within certain Limits of Temperature.—M. Loriton.—The author gives a description of a special apparatus for observing the phenomena of solidification and fusion under the microscope.

A Contribution to the Study of the Alkaloids; on the Detection and Determination of the Bases of the Pyridic and the Quinoleic Series.—M. Oechsner de Coninck.—When it is required to search for and determine this series of bases, it is necessary to prepare the chloro-platinate, and endeavour to modify it with lukewarm water. The quinoleic hydrides are also powerful reducing agents.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 1, 1886.

A New Method for the Determination of the Specific Gravity of Gases, and for their Analyses.—Fried. Lux.—This paper requires the seven accompanying figures.

Determination of the Melting-points of Fats.—C. Reinhardt.—The author's procedure cannot be explained without the four accompanying illustrations. He mentions that the figures given for beef-tallow range from 37° to 52·5°, and those for mutton-tallow from 38° to 52°.

Chemical Examination of Beers in General, and a New Direct Method of determining Alcohol in Fermented Liquors.—E. Bohlig.—This paper cannot be usefully reproduced without the illustration.

Analysis of so-called Swedish Beer.—J. Groinigg This liquid contains very variable quantities of alcohol, extract, sugar, gum, with small quantities of glycerin, and in some cases traces of succinic acid.

The Gravimetric Determination of Zinc, with particular reference to so-called Zinc-Ash.—Dr. L. Marquardt.—This paper will be inserted in full.

New Coloured Reactions of Certain Alkaloids.—W. Lenz.—If a little potassium hydroxide, purified with alcohol, is fused upon the lid of a porcelain crucible with a little water, mixed with a trace of the substance to be examined (preferably dissolved in alcohol), and the whole is then very cautiously and gradually heated over a steady flame, finally to redness; the mass in most cases takes a yellow colour, passing into red or brown, and ultimately becoming carbonised. In the following bases the colours were not characteristic:—Aconitine, anemonine, aspidospermine, atropine, baptisine, bebeerine, berberine, bryonine, brucine, caffeine, cannabine, cantharidine, chelidonine, chlorogenine, codeine, colchicine, colocynthine, colocynthidine, coniine, cotoine, cryptopine, curarine, cyclamine, daturine, delphinine, digitaline, ditaine, duboisine, elaterine, emetine, erythrophlæine, gelsemine, gentisine, helleboreine, hydrocoteine, homatropine, hyoscyamine, hydrastine. hyoscine, kosine, leptandrine, lobeliine, lycoctonine, meconine, morphine, napelline, narceine, narcotine, papaverine, papazotine, pelletierine, peucedanine, physostigmine, pilocarpine, piperine, podophyllotoxine, sabbatine, scillitoxine, scoparine, solanine, sparteine, strychnine, and veratrine. On the contrary, quinine and quinidine give an intense grass-green, cinchonine and cinchonidine a bluish green, and cocaine a greenish yellow, which, on more prolonged heating, passes into a bluish colour, and then into a dirty rose. Apomorphine, sabadilline, and thebaine display at first a faint green colour, which afterwards passes into yellowish brown, and is not to be confounded with the characteristic colours of the quinine group. A sample of chinoline tartrate, bought several years ago, and a pure chinoline from the same source, gave the green colour noticed under quinine; but on testing a recent sample of "purest" chinoline this reaction could not be obtained. Ptomaines obtained from five different dead men, and from a piece of sausage which had occasioned the death of two persons, gave no coloured reaction on fusion with potassa. The author, being prevented by his present engagements from carrying out this investigation, hopes that some other chemist will ascertain the result of adding oxidising and reducing agents to the melted potassa.

A New Absorption-Apparatus for the Determination of Carbonic Acid.—F. Strohmer.—The apparatus cannot be intelligibly described without the figure.

Use of Schœne's Apparatus for Washing Clays and Soils.—Carl Holthof.—The author gets rid of the defects of the apparatus by filling the deepest, curved part so far with mercury that the water in both limbs only just communicates over the surface of the mercury.

Reflux-Condenser for Analytical Extraction-Apparatus.—F. Allihn.—This paper requires its illustration.

Preparation of a Stable Starch Potassium-Iodide Solution.—C. Reinhardt.—The determination of nitrous acid in waters has generally been effected with starch-zinc iodide in preference to the ordinary unstable starch-potassium iodide solution. Alex. Müller has indicated a process for obtaining a permanent solution of starch, treating the starch with potash lye, and thus produces a reagent which becomes clear and keeps for years. The author, taking this as a starting-point, has made some direct experiments on the subject, and finds Müller's statements confirmed. He used this alkaline solution of starch in the titration of iron with stannous chloride, and he has also attempted with success the preparation of a permanent solution of starch-potassium iodide. He puts into an Erlenmeyer flask 5 grms. of starch ground to a fine powder, adds about 50 c.c. of water, shakes well up, washes the starch which clings to the sides of the flask down by means of a washing-bottle, and adds with a pipette 25 c.c. of potash-lye (1 part potassium hydroxide purified with alcohol to 2 parts of water). He shakes well, when there is formed a uniform gelatinous mass. He adds 500 c.c. of water and 2 grms. potassium iodide, and heats flask on an asbestos plate to boiling, shaking frequently, when the solution becomes clear. He lets cool, pours the liquid into a graduated cylinder holding 1000 c.c., fills up to the mark with water, and filters.

This solution does not require to be preserved in the dark.

Simple Arrangement for Azotometers.—Alfonso Rosa.—In determining total nitrogen by the method of Dumas, nitric acid by that of Schultze-Tiemann, and in many gasometric operations, the fingers come in contact with strong alkaline solutions. To avoid this evil the author fills the eudiometer, held perpendicularly with the lye, and lays upon the meniscus of the liquid rising above the opening a paper filter of a rather larger diameter than that of the eudiometer. This filter clings firmly to the aperture and permits the eudiometer to be inverted and brought to the place of its destination without admitting air or wetting the hands with the lye.

Working up Uranium Residues.—Prof. U. Kreusler.—The author reminds us that the method of separating the phosphoric acid by means of tin, recently proposed by Savory, had been published by himself twelve years ago.

Bacteriological Examination of the chief Sources of the Wiesbaden Water-Supply, as well as of a number of Mineral Springs at Schlangenbad, Schwalbach, Soden, and Weilbach.—Robert, Baron von Malapert-Neufville.—The bulk of this very important paper will be inserted as early as possible.

"Microscopic Reactions."—K. Haushofer.—In this book the author gives instructions for the detection of various elements and compounds with the microscope.

A Method of Gas-Analysis.—J. Geppert.—The author's process has been discussed in this journal, vol. xxii., p. 405.

An Effect of Capillarity.—J. U. Lloyd.—From the Chemical News.

The Absolute Unit of Light.—J. Violle.—A notice of the author's proposal to take as standard unit the quantity of light emitted by one square centimetre of platinum at its solidification point.

Prisms for the Polarisation of Light.—K. Feussner.—This treatise is merely mentioned.

Certain Sources of Error in the Balance.—R. Hennig.—A current of air may be produced if an evaporating fluid in a beaker is placed upon one scale. The error may amonnt to 0·4 m.g. A source of error, less common, but sometimes more serious, is electric action produced by friction of the balance-case and consequent attraction of one scale-pan. T. E. Thorpe (*Journal Chem. Soc.*) calls attention to small daily fluctuations of the zero-point.

Preparation of Volumetric Solutions of Exact Strength.—E. Pflüger.—The author uses gauged flasks holding respectively 1, 2, or 4 litres with a small flask fused to the neck above the mark.

Determination of the Specific Gravity of Liquids at Elevated Temperatures.—R. Schiff.—This paper requires the accompanying diagram.

A New Form of Combustion-Tubes.—T. B. T. Bruce Warren.—From the Chemical News.

Apparatus for Determining Carbonic Acid in Absorption Gases.—D. Sidersky.—Unintelligible without the figure.

Small Gas-Furnace for the Production of High Temperatures.—H. Rössler.—(*Chemiker Zeitung.*)

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Oil of Rhodium.—(Reply to "Normal Cyanide.")—This is obtained by the distillation of the "aspalath" of the Canary Islands. A reddish essential oil, formerly valued as an astringent, now disused. See Rees' "Cyclopædia."—S. L.

MEETINGS FOR THE WEEK.

Monday, Feb. 1st.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Friction," by Prof. H. S. Hele Shaw.
—— Society of Chemical Industry, 8. "Notes on Dr. Koch's Water Test," by Gustav Bischof. "The Estimation and Valuation of Copper Ores and Products for Commercial Purposes," Mr. Westmoreland.
Tuesday, 2nd.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "Naucratis," by R. Stuart Poole, LL.D.
Wednesday, 3rd.—Society of Arts, 8. "Artistic Bronze Casting," by George Simonds.
Thursday, 4th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— London Institution 7.
—— Royal Institution, 3. "Metals as affected by Small Quantities of Impurity," by Prof. W. Chandler Roberts-Austen, F.R.S.
—— Chemical, 8. Lecture on "Methods of Bacteriological Research from a Biologist's point of view," by Dr. Klein, F.R.S.
Friday, 5th.—Royal Institution, 9. "The Principles of Domestic Fire-place Construction," by T. Pridgin Teale, M.A.
Geologists' Association.
Saturday, 6th.—Royal Institution, 3. "The History of Volcanic Action in the British Isles," by Archibald Geikie, LL.D., F.R.S.

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THE CHEMICAL NEWS.

VOL. LIII. No. 1367

ON AN ELECTRIC SPECTRUM PECULIAR TO THE RARE EARTHS OF THE TERBIUM GROUP.

By M. LECOQ DE BOISBAUDRAN.

Some years ago I observed and sketched a peculiar spectrum, which appeared with various terbic oxides when the induction-spark struck on the surface of their hydrochloric solutions. These oxides (complex mixtures confounded together under the name of terbia) contain very variable proportions of yttria, holmia, ytterbia, samaria, erbia, and of the yellow earth. The spectra of their hydrochloric solutions comprise at least the rays of yttria and ytterbia, this latter body being always very abundant in such mixtures. It was nevertheless possible to show that the special spectrum in question could not be ascribed to any of the known earthy metals except holmium and terbium, the latter being supposed to be characterised by the yellow colour of its oxide.

The numerous fractionations which I have carried out since that time have placed in my hands some series of products still containing several elements, though practically freed from the bodies formerly known which yield spectra with their hydrochloric solutions exposed to the ordinary induction-spark. The special spectrum is thus seen very well in the absence of the rays of Yt, La, Tu, Ya, Sc, Yb, and by means of solutions which show by absorption very little or none of Di, Sm, Er, Tu. In the conditions of the experiment cerium, thorium, and zirconium emit no rays, so that our spectrum can be attributed only to holmium, terbium, to a new body, or, lastly, to the earths which produce the fluorescences $Z\alpha$ and $Z\beta$.

The yellow tint of its oxide when calcined in the air has always been considered as peculiar to and characteristic of terbium. It seems to me, therefore, very natural to retain the name terbia for the most coloured earth of the group. If this is admitted the special spectrum cannot be attributed to terbium, since it appears slightly more brilliant with the oxides which are slightly coloured than with those, much darker, which are derived from the fractionation of one and the same yellow earth by means of potassium sulphate. The least soluble double sulphates yield the most coloured earth.

Admitting, in the absence of proof to the contrary, the non identity of $Z\alpha$ and $Z\beta$, the spectrum in question seems not belonging to $Z\beta$, the fluorescence of which is the finest with the most deeply coloured earths.

The special electric spectrum follows, in its degrees of intensity, a movement in the same direction as the absorption-spectrum of holmium, if we consider the successive stages of each of my fractionations by potassium sulphate. The variations of intensity do not, indeed, appear quite proportional; but on comparing the substances obtained by fractionation (always by means of potassium sulphate), we observe so well-marked deviations between the intensities of the absorption-spectrum of holmium and of the electric spectrum, that it seems to me difficult to attribute this latter to holmium.

The uncertainty which still prevails concerning the manner of producing the fluorescences Sm, $Z\alpha$, and $Z\beta$, —an uncertainty which may throw a doubt on the conclusions drawn from the comparison of the intensities of these fluorescences,—does not exist in the same degree in case of the electric spectrum. Therefore my impression is that holmium is not the cause of our spark spectrum.

As for the fluorescence $Z\alpha$ it is remarkable to see it follow the variations of the special electric spectrum, not merely within one and the same function, but also when we compare products of different origins. The relative intensities of the electric spectrum and of the fluorescence $Z\alpha$ seem to vary a little, but, considering our still very incomplete knowledge of the fluorescences, I do not feel warranted in concluding that these variations indicate clearly the existence of two distinct elements.

Nevertheless, to avoid future confusions of nomenclature, I designate provisionally the body producing the electric spectrum as $Z\gamma$. It is composed of several bands and rays which always preserve substantially their relative lustres, and which therefore must be considered for the present as belonging to a single element.

The following are the approximate positions of the principal rays and bands of $Z\gamma$:—

	Positions on my Micrometer.	λ	Observations.
	101⅓	583·5	Nebulous ray; fairly well marked. It stands out on a small very nebulous band, carrying other less marked maxima.
	102⅓ (about)	,,	Indistinct commencement of band.
	104⅓	575·0	Nebulous ray; broad and well marked; much stronger than 101⅓.
α	105·⅞	570·0	Very nebulous ray; moderately broad, very easily visible, but much weaker than 104⅓; terminates the band.
	106·⅛	,,	Very nebulous extremity of the band.
	121⅓ (about)	,,	Nebulous commencement of a small band, which increases in its entire from left to right, This band bears several fine, but slightly nebulous, rays (visible with a narrow slit), which increase in intensity from the left side to the ray 122·15, the most brilliant of all. From this ray to the extremity of the band the light is very faint.
	121·95 (about the half apparent)	526·9	Apparent middle of the entire band. This is the position measured with a rather broad slit.
	122·15	525·9	Strongest ray. Forms the right margin of the principal part of the band. Very well marked.
	122⅓	,,	Nebulous extremity of the band. This band is slightly fainter than α, 102⅓ to 106·⅛.

—*Comptes Rendus* (vol. cii., p. 153).

ON THE USE OF METALLIC OXIDES FOR DETECTING COAL-TAR COLOURS IN WINES.

By P. CAZENEUVE.

THE author brings before the Academy a certain and very precise general method for detecting, in wines, magenta, azo-colours, and others, so much employed at present. This method is based upon the use of metallic oxides, properly so called. He has employed in particular yellow mercury oxide, moist lead hydroxide, and gelatinous ferric hydroxide.

The colouring-matter of wine—a kind of tannin—is a feeble acid, forming insoluble lakes with a great number of metallic salts, including those of lead, mercury, and iron. An excess of these salts either re-dissolves the metallic lake or acts upon foreign artificial colouring-matters. The author thought that the direct intervention of the oxides of these metals, which are feeble and insoluble bases, would fix the normal colouring-matter of wine, without destroying most of the coal-tar colours, and without forming combinations with them. Experiment has confirmed these views.

A. *Yellow Mercury Oxide.*—This oxide, both in the cold and in heat, retains the normal colouring-matter of wine, and, in addition, cochineal and the vegetable colours used for wines, and this in a complete manner: 0·20 grm. of the oxide suffices to decolourise 10 c.c. of wine.

On the contrary, it lets pass on filtration, both in the cold and in heat, the sulpho-conjugated derivative of magenta even in traces; further, especially in heat, the following colouring-matters:—Bordeaux red B, soluble red (the sodium salt of the sulpho-conjugated derivative of roccelline), purple-red, croceine 3 B, scarlet (Biebrich red), ponceau R, ponceau B, orangé R, orangé RRR, orangé II, orangé RR, tropæoline M, tropæoline II, yellow I, fast yellow, binotro-naphthol yellow, yellow NS. These colours pass away entirely, even if present in small quantity.

The mercury oxide seems to keep back a part of the following colours: — Orangé I, safranine, chrysoidine, chrysoine, methyl-eosine, yellow II, red NN, red I, ponceau RR. It retains entirely erythrosine, eosine J, methylene blue, Coupier's blue, diphenylamine blue.

All these experiments, like the following, have been made with small proportions of the colouring-matter representing the fourth, or even less, of the total colouration of the wine. They have always been performed along with wine, as the conditions of the medium change the reaction. We cite the case of erythrosine, which passes away in an aqueous solution, but is retained in presence of wine. The heat used was carried to the boiling-point.

B. *Lead Hydroxide.*—This hydrate, containing 50 per cent of water, has been applied in the proportion of 2 grms. to 10 c.c. of wine. In the cold, after agitation for a minute or two, it retains the normal colouring-matter of wine, which is also effected by bringing the whole to a boil. All vegetable colours and cochineal are also retained.

Contrary to mercury oxide, this oxide lets the rosanilines pass very readily. (The author has not previously mentioned that they are kept back by mercury oxide.) Rosaniline hydrochlorate, sulphate, acetate, oxalate, and arseniate have been tried, the filtrate being acidulated so as completely to regenerate the salt of rosaniline. It lets pass orangé I (with a rose tint), safranine, orangé R, orangé RRR (with a rose tint), tropæoline M, tropæoline II, chrysoidine, chrysoine, orangé II, methyl-eosine, fast yellow, binitro-naphthol yellow, yellow NS, yellow I, ponceau B. It retains partially eosine J, yellow II, red I, ponceau RR.

Like mercury oxide it retains entirely methylene blue, Coupier's blue, diphenylamine blue, and erythrosine; but unlike mercury oxide—and the fact is remarkable—it retains the sulpho-conjugated derivative of magenta, Bordeaux red B, purple-red, and the soluble red of roccelline.

C. *Gelatinous Ferric Hydroxide.*—This oxide has been used containing 90 per cent of water, 10 grms. to 10 c.c. of wine. It is mixed in the cold, and the mixture heated to a boil. Pure wine is completely decolourised; cochineal and the vegetable dyes are retained. The following colours pass:—Erythrosine, which is retained by mercury and lead oxides; then the sulpho-conjugated derivative of magenta, Bordeaux red B, purple, soluble red, and fast yellow. All the rose anilines except the sulpho-conjugated compound (acid magenta or magenta S) are retained. The less important colours have not yet been examined.

Stannous hydrate and zinc hydrate give encouraging results. Some colours pass, whilst others are retained totally or partially, with the formation of lakes of different and often of characteristic colours.

Thus there is possible a general method for the distinction of these colours, or for their separation. The comparison with a standard solution, dyeing silk and wool, the reaction of strong sulphuric acid, spectral reaction (Girard and Pabst), and the solubility in amylic alcohol will permit the recognition of their nature.

The treatment of wine with magnesia and hot amylic alcohol isolates and distinguishes many of the artificial blues which are kept back by the oxides of lead, iron, and mercury.

The author hopes to extend this method so as to distinguish the natural colours. Thus stannous hydrate easily retains the normal colour of wine, but lets cochineal and orchil pass. From wine it is but a step to recognise artificial colours in syrups, liqueurs, &c. — *Comptes Rendus*, vol. cii., p. 52.

AN ELECTRICAL FURNACE FOR REDUCING REFRACTORY ORES.*

By T. STERRY HUNT.

The application of electricity in the extraction of metals has hitherto been chiefly confined to the electrolysis of dissolved or fused compounds of these by various methods. The power of electric currents to generate intense heat in their passage through a resisting medium has, however, long been known, and the late W. Siemens thereby succeeded in fusing considerable quantities of steel. But it was reserved to Messrs. Eugene H. and Alfred H. Cowles, of Cleveland, Ohio, to take a new step in the metallurgic art by making the heat thus produced a means of reducing, in the presence of carbon, the oxides not only of the alkaline metals, but of calcium, magnesium, manganese, aluminium, silicon, and boron, with an ease that permits the production of these elements and their alloys with copper and other metals on a commercial scale.

In the apparatus devised and now employed by the Messrs. Cowles, a column of fragments of well-calcined charcoal, so prepared and arranged as to present the requisite electrical resistance, is imbedded horizontally in finely pulverised charcoal, and covered by a layer of the same material coarsely broken, the whole being arranged in a box of fire-brick, covered with perforated tiles and opened at the ends to admit two carbon electrodes an inch and a half in diameter. Through these the current from a dynamo-electric machine of 30 horse-power is now made to traverse the central core of carbon fragments, whereby such a temperature is at once produced therein that platin-iridium may be instantly melted, and the most refractory oxides already named are not only fused and volatilised, but reduced to their elemental state, with formation of carbonic oxide gas.

If alumina in the form of granulated corundum is mingled with the carbon in the electric path, aluminium is rapidly liberated, being in part carried off with the escaping gas, and in part condensed in the upper layer of charcoal. In this way are obtained considerable masses of nearly pure aluminium, and others of a crystalline compound of the metal with carbon. When, however, a portion of granulated copper is placed with the corundum an alloy of the two metals is obtained, which is probably formed in the overlying stratum, but, at the close of the operation, is found in fused masses below. In this way there is got, after the current has passed for an hour and a half through the furnace, from 4 to 5 pounds of an alloy containing from 15 to 20 per cent of aluminium, and free from iron. On substituting this alloy for copper, in a second operation, a compound with over 30 per cent of

* Read Sept. 17, 1885, before the Halifax, N.S., Meeting of the American Institute of Mining Engineers.

aluminium is obtained. Already the small experimental plant, with a 30 horse-power dynamo, is producing daily over 5 pounds of aluminium in the form of a rich and brittle alloy, which, by suitable additions of copper, is converted into different grades of aluminium bronze. The valuable qualities of these are so well known that it is only their great cost hitherto that has prevented their more general use in the arts. They are now offered for sale at Cleveland on a basis of 5 dollars a pound for the contained aluminium.

The reduction of silicon is even more easy than that of aluminium. When siliceous sand, mixed with carbon, is placed in the path of the electric current, a part of it is fused into a clear glass and a part reduced, with the production of considerable masses of crystallised silicon, a portion of this being volatilised and re-converted into silica. By the addition of granulated copper there is readily formed a hard, brittle alloy, holding 6 or 8 per cent of silicon, from which silicon bronzes can be cheaply made. The direct reduction of clay gives an alloy of silicon and aluminium, and with copper a silico-aluminium bronze that appears to possess properties not less valuable than those of the compound already mentioned. Even boric oxide is rapidly reduced, with evolution of copious brown fumes, and the formation in presence of copper of a boron bronze that promises to be of value; while, under certain conditions, crystals of what appears to be the so-called adamantoid boron are formed. In some cases, also, crystalline graphite has been produced, apparently through the solvent action of aluminium upon carbon.

Remarkable results are got by alloying small quantities of aluminium with an admixture of copper and nickel. One of these compounds, designated as Hercules metal, broke with a strain of 111,000 pounds to the square inch, with an elongation of 35-100ths, while a 10 per cent aluminium bronze broke with 109,000 pounds. An addition of from 2 to 3 per cent of aluminium to brass greatly increases its tensile strength, and renders it less susceptible to oxidation. While 15 or 20 per cent of aluminium with copper yields a brittle compound, an addition of 10 per cent of copper gives to pure aluminium a great increase of hardness and tenacity, forming an alloy that may have a wide application. It may be added that the difficulties in the way of getting together the reduced aluminium without the aid of the copper promise to be overcome at an early day, so that we may expect the cheap production of such alloys and of pure aluminium.

The Messrs. Cowles, in their later work, have been aided by the chemical skill of Prof. C. F. Mabery, now of Cleveland, who is associated with them in one of their patents. These now cover not only the reduction of aluminium, silicon, and boron, as described, but the extraction of manganese, magnesium, and the alkaline metals by the electric furnace. I had the pleasure of hearing Prof. Mabery give the first scientific notice of this discovery before the American Association for the Advancement of Science, at Ann Arbor, August 28th, and then spoke of the early results of Deville and those of Debray on aluminium and its alloys, having myself witnessed many of the experiments of both of these chemists thereon. I also insisted that the importance of this new instrument that the Messrs. Cowles have placed in the hands of chemists, for producing and controlling degrees of temperature never before obtained, can scarcely yet be estimated, either in its economic or its scientific aspect. This heat of the furnace realises the dream of the alkahest, or universal solvent of the alchemists, and he who can rightly use it will be worthy of the ancient title of *Magister Magnus in igni*.

I may add that, through the courtesy of these gentlemen, I have since been enabled to spend two entire days in their experimental works at Cleveland, with the Brothers Cowles and Professor Mabery, when they explained to me several points not yet made public, and allowed me to direct experiments with one of their furnaces. The fusion of quartz and the reduction of silicon without the presence of copper was repeated; also the reduction of boron and the formation of boron bronze, with many other interesting experiments. I then suggested trials for the reduction of titanium, both from rutile and from titanic iron ore, which will probably soon be made.

The present plant at Cleveland is but a first experimental one, and has only been in operation a few months. The Cowles Electric Smelting Company has secured a large water-power at Lockport, New York, and a dynamo-electric machine of 125 horse-power is now building for them at the Brush Works in Cleveland, which will soon be in operation at Lockport, and will permit the establishment of the electric furnace on a larger scale. A series of experiments of the products got by this remarkable discovery is, by the courtesy of these gentlemen, placed before the members of the Institute.—*Canadian Record of Science* (vol. ii., No. 1.)

ANALYSES OF SOME IRON ORES.

By J. CUTHBERT WELCH.

(Continued from page 53.)

II. *Limonite.*

Formula = $2Fe_2O_3.3H_2O$.

This requires—

Fe_2O_3	85·56
H_2O	14·44
	100·00

1. From Weardale, Durham. Compact, botryoidal, and with a radiating structure. Lustre in places shining and in others dull. Brittle, with a conchoidal fracture. Colour blackish brown. Streak brownish red. Three determinations of its specific gravity gave 3·410, 3·403, and 3·422; mean = 3·412. Metallic iron = 99·753 per cent.

Data.

Iron—

0·25 grm. required 14·37 c.c. potassium bichromate.

Hygros. water—

5 grms. gave 0·1078 grm. hygroscopic water.

Combined water—

5 grms. gave 0·7256 grm. combined water.

Silica—

5 grms. gave 0·0248 grm. silica.

Sulphur—

5 grms. gave 0·0918 grm. barium sulphate.

Magnesia—

5 grms. gave 0·0109 grm. magnesium pyrophosphate.

Phosphorus—

4 grms. gave 0·0008 grm. magnesium pyrophosphate.

Arsenic—

4 grms. gave 0·0104 grm. magnesium pyroarsenate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	82·120	83·935
H_2O (hygros.) ..	2·156	—
H_2O (combined)..	14·512	14·833
SiO_2	0·496	0·507
S	0·252	0·257
MgO	0·078	0·079
P_2O_5	0·013	0·013
As	0·126	0·129
	99·753	99·753

This gives—

Fe_2O_3	84·982
H_2O	15·018
	100·000

2. A stalactitic specimen from Restormel, near Lostwithiel, Cornwall. Very brittle, showing a fibrous structure, but with no apparent radiation, although this might be due to the fact that the specimen consisted of several small pieces and not of one mass. Colour deep yellowish brown. Earthy in appearance, but not to the touch nor in composition. Four determinaiions of its specific gravity gave 3·951, 3·942, 3·941, and 3·958; mean = 3·948. Metallic iron = 58·399 per cent.

Data.

Iron—
0·25 grm. required 14·6 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0045 grm. hygroscopic water.
Combined water—
5 grms. gave 0·7485 grm. combined water.
Silica—
5 grms. gave 0·0366 grm. silica.
Lime—
5 grms. gave 0·0209 grm. calcium sulphate.
Sulphur—
5 grms. gave 0·1110 grm. barium sulphate.
Phosphorus—
4 grms. gave 0·0021 grm. magnesium pyrophosphate.
Lead—
5 grms. gave 0·0031 grm. lead sulphate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	83·428	83·503
H_2O (hygros.) ..	0·090	—
H_2O (combined)..	14·970	14·984
SiO_2	0·732	0·733
S	0·305	0·305
CaO	0·172	0·172
P_2O_5	0·034	0·034
Pb..	0·053	0·053
Al_2O_3, Mn, and FeO	traces	traces
	99·784	99·784

This gives—

Fe_2O_3	84·786
H_2O	15·214
	100·000

3. A botryoidal mass from Salisbury, Connecticut, U.S. Has a radiating structure. Very hard and brittle, yielding a conchoidal fracture. Colour greyish brown. Streak yellowish brown. Metallic lustre. Its specific gravity = 3·524. Metallic iron = 57·204 per cent.

Data.

Iron—
0·25 grm. required 14·3 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0565 grm. hygroscopic water.
Combined water—
5 grms. gave 0·7198 grm. combined water.
Alumina—
5 grms. gave 0·0104 grm. alumina.
Silica—
5 grms. gave 0·0761 grm. silica.
Sulphur—
5 grms. gave 0·0269 grm. barium sulphate.
Lime—
5 grms. gave 0·0420 grm. calcium sulphate.
Manganese—
4 grms. gave 0·0005 grm. trimanganic tetroxide.
Magnesia—
5 grms. gave 0·0212 grm. magnesium pyrophosphate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	81·720	82·658
H_2O (hygros.) ..	1·130	—
H_2O (combined)..	14·396	14·561
Al_2O_3	0·208	0·210
SiO_2	1·522	1·540
S	0·074	0·075
CaO	0·346	0·350
MnO	0·012	0·012
MgO	0·153	0·155
	99·561	99·561

This gives—

Fe_2O_3	85·022
H_2O	14·978
	100·000

4. From Siegen, near Bonn, Saxony. This was a portion of a crystal which was evidently a pseudomorph of calcite. Colour reddish brown. Streak dark yellowish brown. Dull to shining. Compact. The specific gravity of the inner portion of the crystal = 3·925. Metallic iron = 58·999 per cent (inner portion of crystal), or 57·899 (whole mass).

A. Inner portion of Crystal.

Data.

Iron—
0·25 grm. required 14·75 c.c. potassium bichromate.
Hygros. water—
5 grms. gave 0·0108 grm. hygroscopic water.
Combined water—
5 grms. gave 0·7267 grm. combined water.
Silica—
5 grms. gave 0·0142 grm. silica.
Lime—
5 grms. gave 0·0594 grm. calcium sulphate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	84·285	84·468
H_2O (hygros.) ..	0·216	—
H_2O (combined)..	14·534	14·565
SiO_2	0·284	0·285
CaO	0·407	0·408
	99·726	99·726

This gives—

Fe_2O_3	85·292
H_2O	14·708
	100·000

B. The Whole Crystal.

Data.

Iron—
0·5 grm. required 28·95 c.c. potassium bichromate.
Hygroscopic water—
5 grms. gave 0·0317 grm. hygroscopic water.
Combined water—
5 grms. gave 0·6813 grm. combined water.
Alumina—
5 grms. gave 0·0261 grm. alumina.
Silica—
5 grms. gave 0·0208 grm. silica.
Copper—
6 grms. gave 0·0037 grm. copper subsulphide.
Sulphur—
5 grms. gave 0·0759 grm. barium sulphate.
Lime—
5 grms. gave 0·1232 grm. calcium sulphate.

Magnesia—

5 grms. gave 0·0483 grm. magnesium pyrophosphate.

Phosphorus—

4 grms. gave 0·0033 grm. magnesium pyrophosphate.

Arsenic—

4 grms. gave 0·0080 grm. magnesium pyroarsenate.

Percentage.

	Original.	Dried at 100° C.
Fe_2O_3	82·714	83·244
H_2O (hygros.) ..	0·634	—
H_2O (combined)..	13·626	13·713
Al_2O_3	0·522	0·525
SiO_2	0·416	0·419
CuO	0·062	0·063
S	0·208	0·209
CaO	1·014	1·020
MgO	0·348	0·350
P_2O_5	0·053	0·053
As..	0·097	0·098
	99·694	99·694

This gives—

Fe_2O_3	85·856
H_2O	14·144
	100·000

(To be continued).

DETERMINATION OF WATER IN CRYSTALLINE BORIC ACID.

By H. GILBERT.

STOLBA'S process for the determination of water in boric acid is inapplicable in presence of sulphuric acid, which occurs in Tuscan and Californian samples, and of ammonia, which is met with in the former. In such cases the author introduces the boric acid into milk of lime, evaporates, and ignites. He places 1·5 grm. of commercial quicklime in a platinum capsule, ignites with the blast until the weight is constant, adds then 10 c.c. of water, stirs 2 grms. boric acid into the milk of lime, and evaporates to dryness. He heats then at first with a small, and then with a large, flame, and finally—to expel the carbonic anhydride which has been taken up—he ignites with the blast for five minutes. The loss of weight is water and ammonia, which is determined separately and deducted.—*Repertorium Anal. Chemie* (vol. v., p. 374).

TITRATION WITH LACMOID AS AN INDICATOR.

By G. BURKHARD.

THE author has carried out a series of comparative titrations to determine the applicability of lacmoid as compared with litmus. In the titration both of caustic and carbonated alkalies and earths, the results of both were alike. Lacmoid is permanent in boiling solutions, acid or alkaline. On the slightest excess of acid or alkali the change of colour ensued with great distinctness, lacmoid being apparently more sensitive than litmus. In lime solutions it indicates 0·00014 per cent by volume of lime, and in soda solutions 0·00025 of soda. It has the advantage over litmus in permanence, in the purity of the red and blue colours, and in the abruptness of the change. As compared with other sensitive indicators it has the advantage of universal applicability.—*Chemische Industrie*, from *Schädler*.

THE ANALYSIS OF COMMERCIAL SAMPLES OF IODINE.

By G. WEISS.

THE author received some samples which by appearance might contain 99 to 99·5 per cent of actual iodine, but which on titration showed more than 100 per cent. They were found to be contaminated with bromine to the extent of 3 per cent. For the separation and determination of iodine, bromine, and chlorine, Weiss heats the substance in a current of air with an excess of a moderately strong solution of ferric sulphate, receives the iodine in a strong solution of potassium iodide, and titrates it with sodium hyposulphite. The residue is cooled, mixed with potassium permanganate, heated to 50° to 60°, and treated with a current of air. The bromine evolved is received in ammonia and determined by titration, or, preferably, gravimetrically as silver bromide. The chlorine is then calculated from the difference.—*Repert. Anal. Chemie.*

A DEFECT IN THE VOLUMETRIC DETERMINATION OF CHLORINE BY MOHR'S PROCESS.

By G. BISCARO.

IF nitrates, especially those of the alkalies and earths, are simultaneously present, the precipitation of the red silver chromate often takes place too late, whether because such nitrates form double salts with silver nitrate which are not precipitated by potassium chromate, so that a decided excess of silver becomes necessary, or that the silver chromate already formed is slightly soluble in those waters. This observation is of especial importance in determinations of chlorine in organic bodies which have been ignited with lime and then dissolved in nitric acid. Besides the nitrates other salts seem to interfere in a similar manner in Mohr's process.—*Ann. de Chim. Med. Farm. und Chemische Industrie.*

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.*

By P. T. CLEVE.

(Continued from p. 47).

Bromoaurate of Samarium, $SmBr_3+AuBr_3+10H_2O$.

This compound crystallises in large, brilliant, and well formed thick rhombic tablets of a brown, almost black, colour. It is very deliquescent.

1·2964 grm. gave 0·6340 grm. Au+$Sm_2{}_3SO_4$, which left after washing with water 0 2527 grm. Au.

0·8427 grm. was treated with sulphurous acid and gave 0·1633 grm. Au and 0·9176 grm. AgBr+0·0186 grm. Ag.

In per cent—

			Calculated.	
Sm	15·04	—	150	14·91
Au	19·49	19·38	196	19·48
Br	—	47·98	480	47·71
H_2O	—	(17·55)	180	17·89
			1006	100·00
$Sm_2{}_3SO_4$+Au..	48·90			48·71

* Presented to the Royal Society of Sciences of Upsala, Feb. 13, 1885.

Specific gravity—
0·8903 grm. coarse pieces of crystals, t° 21·2°, 3·383
0·9726 „ „ „ „ 3·398
Mean of both determinations, 3·390.
Molecular volume, 296·7.

Ferrocyanide of Samarium and Potassium, $SmKFe6CN+5H_2O$ (or $3H_2O$ dried at 100°).

A solution of ferrocyanide of potassium yields nitrate of samarium a light coloured, dirty yellowish, finely divided and non-crystalline precipitate, which, on washing, passes through the filter-paper. The precipitate was dried in the air and then analysed.

0·8548 grm. lost on heating to 100° 0·0460 grm. The dried substance was then carefully ignited, and the residue dissolved in HCl. The solution yielded with NH_3 0·4465 grm. $Sm_2O_3+Fe_2O_3$ and the filtrate 0·1133 KCl.

In per cent—

	Air-dried.	Dried at 100°.	Calculated. Formula with $5H_2O$.	Calculated. With $3H_2O$.
$Sm_2O_3+Fe_2O_3$..	52·23	55·21	51·72	55·81
K	6·94	7·34	7·96	8·59

The numbers found do not agree sufficiently well with those obtained by calculation, so that there may be some doubt as to the exact amount of water.

Platinocyanate of Samarium, $2Sm(CN)_3+3Pt(CN)_2+18H_2O$.

This compound was obtained by slowly evaporating, over oil of vitriol, the solution resulting from the double decomposition of platinocyanide of barium and sulphate of samarium. The compound forms beautiful tolerably large prisms, which appear yellow by transmitted and blue by reflected light. It is stable in the air, and looses at 110° 16·33 per cent H_2O or 14 mols. (= 16·57).

The analysis, already published,* gave in per cent:—

Pt	38·69	38·46
$Pt+Sm_23SO_4$..	77·49	77·12

Specific gravity—
1·5721 grm., coarsely crushed crystals, t° 20·8°, sp. gr. 2·743
1·8872 „ „ „ „ „ 2·745
Mean of both determinations, 2 744.
Molecular volume, 554·3.

Sulphocyanate of Samarium, $Sm(CNS)_3+6H_2O$.

A solution of the oxide in sulphocyanic acid was evaporated over oil of vitriol. Slender, yellow, and highly deliquescent needles were deposited from the syrupy solution. The salt was pressed between filter-paper as rapidly as possible and analysed.

0·8947 grm. was dissolved in water, oxalic acid was added, and the whole evaporated to dryness and ignited. There remained 0·3541 grm. Sm_2O_3.

In per cent—

		Calculated. 150	Calculated. 34·72
Sm	34·12		
CNS	—	174	—
H_2O	—	108	—
		432	

The analysis gave 0·6 per cent samarium too little, which may be ascribed to the extreme hygroscopicity of the salt.

Sulphocyanate of Samarium with Cyanide of Mercury, $Sm(CNS)_3+3Hg(CN)+12H_2O$.

The mixed solutions of the simple salts deposit on cooling elongated, often asbestos-like needles, which are easily soluble in hot water.

0·5182 grm. lost on heating to 100° or 110° 0·0835 grm. H_2O.

0·5115 grm. was dissolved in water, acidulated with hydrochloric acid, and the solution precipitated with H_2S. Thus obtained 0·2783 grm. HgS, and from the filtrate 0·0700 grm. Sm_2O_3, precipitated as oxalate.

In per cent—

		Calculated. 150	Calculated. 11·57
Sm	11·80		
Hg	46·91	600	46·30
CNS..	—	174	—
CN	—	156	—
H_2O..	16·11	216	16·67
		1296	

Specific gravity—
1·1868 grm., t° 18·4°, sp. gr. 2·749
1·2028 „ „ 18 „ 2·742
Mean of both determinations, 2·745.
Molecular volume, 472·1.

Nitrate of Samarium, $Sm3NO_3+6H_2O$.

The concentrated solution deposits, when slowly evaporated over oil of vitriol, topaz-yellow well-developed crystals, but often solidifies to a mass of flat needles. On heating the salt fuses easily, emits red vapours, and leaves a voluminous and porous mass of oxide.

1·0969 grm. gave 0·4274 grm. Sm_2O_3.
0·7211 grm. gave 0·2841 grm. Sm_2O_3.

In per cent—

			Calculated. 174	Calculated. 39·19
Sm_2O_3	38·96	39·40		
N_2O_5	—	—	162	—
H_2O	—	—	108	—
			444	

Specific gravity—
1·3792 grm., t° 20·4°, sp. gr. 2·370
1·6196 „ „ „ 2·380
Mean of both determinations, 2·375.
Molecular volume, 186·9.

Iodate of Samarium, $Sm3IO_3+6H_2O$ (dried at 100° $2H_2O$).

A solution of iodic acid added to a solution of a salt of samarium (the acetate) produces a voluminous, amorphous, and whitish precipitate. Dried between paper the salt lost at 100° 9·27 per cent, or 4 mol. H_2O (calc. 9·19).

I. 0·4555 grm. iodate, dried at 100°, treated with a solution of sulphurous acid and precipitated with nitrate of silver, gave 0·4538 grm. AgI. From the filtrate 0·1171 grm. Sm_2O_3 was obtained.

II. 0·4983 grm. gave 0·4981 grm. AgI and 0·1254 grm. Sm_2O_3.

In per cent—

		I.	II.	Calculated. 174	Calculated. 24·47
Sm_2O_3		25·71	25·16		
I_2O_5		70·80	71·04	501	70·46
H_2O		(3·49)	(3·80)	36	5·07
				711	100·00

Periodate of Samarium, $SmIO_5+4H_2O$.

A solution of periodic acid gives with a solution of the acetate or of the nitrate of samarium a voluminous amorphous precipitate, which, after a short time, changes into small colourless or light yellow prisms with wedge-shaped ends. The salt does not lose water at 100°. Heated over a gas-burner it gives off violet vapours, turns black, and finally leaves a cinnamon-coloured residue of an oxyiodide.

* *Journal of the Chemical Society*, 1883, p. 368.

I. 0·5231 grm., treated in the same manner as the iodate, gave 0·2931 grm. AgI and 0·2064 grm. Sm_2O_3.

II. 0·3812 grm. gave 0·2113 grm. AgI and 0·1484 grm. Sm_2O_3.

In per cent—

	I.	II.	Calculated.	
Sm_2O_3	39·46	38·93	174	40·56
I_2O_7	43·63	43·16	183	42·66
H_2O	(16·91)	(17·91)	72	16·78
			429	100·00

Specific gravity—

0·9834 grm. small crystals, t° 21·2°, sp. gr. 3·793.

Molecular volume, 113·1.

Sulphate of Samarium, $Sm_23SO_4+8H_2O$.

This compound forms small topaz-yellow well-developed crystals which are soluble with difficulty in water. The analyses have already been published.* The crystallised salt contains 19·66 per cent H_2O (calc. 19·67) and the anhydrous salt 59·19 per cent Sm_2O_3 (calc. 59·18).

Sp. gr. of the crystallised salt—

1·3454 grm., small crystals, t° 18·3°, sp. gr. 2·928
1·2293 „ „ „ „ 2·932

Mean of both determinations, 2·930.
Molecular volume, 249·6.

Sp. gr. of the anhydrous salt—

1·3027 grm., t° 18·3°, sp. gr. 3·898.

Molecular volume, 150·8.

Sulphate of Samarium and Potassium, $2Sm_23SO_4+9K_2SO_4+3H_2O$.

This double salt forms a white, sparingly soluble, heavy powder. A saturated solution of this salt in sulphate of potash solution contains about 0·05 grm. Sm_2O_3 in 100 c.c. The analysis has already been published† and gave—

		Calculated.
Sm_2O_3	25·17	24·87
K_2O	31·00	30·31
H_2O	1·96	1·93

Sulphate of Samarium and Ammonium, $SmNH_4,2SO_4+4H_2O$.

The mixed solutions of the simple salts give by spontaneous evaporation small pale-yellow crystals which are soluble with difficulty. The salt loses 3 mols. H_2O at 110°.

0·7168 grm. left by strong calcination 0·2888 grm. Sm_2O_3.

0·5324 grm. gave 0·2130 grm. Sm_2O_3.

2·402 grm. lost by 220° 0·396 grm. H_2O.

In per cent—

				Calculated.	
Sm_2O_3	40·29	40·01	—	174	40·28
$(NH_4)_2O$	—	—	—	26	—
SO_3	—	—	—	160	—
H_2O	—	—	16·49	72	16·67
				432	

Specific gravity of the crystallised salt—

1·2339 grms., small crystals, t° 18·4°, sp. gr. 2·674
1·2297 „ „ „ „ 2·677

Mean of both determinations, 2 675.
Molecular volume, 161·5.

Specific gravity of the anhydrous salt—

1·4657 grms. t° 18° . . . . . sp. gr. 3·191

Moleeular volume: 112·8. The molecular volume of $(NH_4)_2SO_4 = 74·56$ (Pettersson), of Sm_23SO_4 150·8, and $\frac{(NH_4)_2SO_4+Sm_23SO_4}{2} = 112·7$.

Sulphate of Samarium and Sodium, $SmNa2SO_4 + H_2O$ (?).

If the saturated solutions of the simple salts be mixed, very small and indistinct crystals are deposited. The salt does not lose water at 100°. The saturated solution of this salt in sulphate of sodium solution contains about 0·24 grm. Sm_2O_3 in 100 c.c. The sp. gr. was found to be 3·54.

0·5481 grm. lost on heating to incipient redness 0·0307 grm. H_2O, and gave 0·2416 grm. Sm_2O_3 and 0·1106 grm. Na_2SO_4.

0·5336 grm. lost 0·0300 grm. H_2O and gave 0·6454 grm. $BaSO_4$.

In per cent—

			Calculated.	
Sm_2O_3	44·08	—	174	45·43
Na_2O	8·81	—	31	8·09
SO_3	—	41·53	160	41·78
H_2O	5·60	5·62	18	4·70
			383	100·00

Hyposulphate of Samarium.

The solution obtained by double decomposition from the sulphate of samarium and the hyposulphate of barium yields on evaporation over oil of vitriol a thick liquid, which deposits the hyposulphate in long slender needles, which were not analysed, as they could not be perfectly freed from the thick mother-liquor.

(To be continued).

Micro-chemical Demonstration of Brucine and Strychnine in the Seeds of the Strychnaceæ.—O tto Lindt (*Schweiz. Wochenblatt Pharm.* and *Chem. Zeitung*).—If to a thin section of the seed, freed from fat by means of petroleum ether, there is applied selenic acid mixed with ½ to ¼ part of nitric acid (sp. gr. 1·2), if brucine is present the cell-walls containing it are quickly coloured bright red, passing into orange and yellow. For the detection of strychnine the author uses a solution of cerium sulphate and sulphuric acid. Before applying it the sections must be freed from brucine, glucose, fat, &c., by repeated treatment with petroleum ether and absolute alcohol, the latter of which dissolves brucine. The reagent colours cell-membranes a violet blue, which soon disappears.

Adulteration of Ether with Petroleum Ether.—Vitali (*Orosi*).—The author treats a moderate quantity of ether with strong sulphuric acid in a graduated cylinder. The ether is taken up by the acid, and if it is pure there remains only a homogeneous liquid. If there remains a supernatant stratum he tries whether its volume is reduced by treatment with more sulphuric acid. A portion of the supernatant liquid is then removed with a pipette and tested with a trace of iodine, which dissolves in petroleum ether with a violet colour, but with a brownish yellow in ether. B. J. Borrigter (*Archiv der Pharmacie*) mentions that ether often contains hydrogen peroxide. Such ether liberates iodine from potassium iodide and colours a portion of potassium hydroxide yellowish brown. On distilling such ether there occurs at last an explosion with the formation of a white vap ur. Aldehyd is always found in such ether along with hydrogen peroxide. Such samples, after prolonged treatment with potassa, give no colouration with a fresh portion of potassa, and cease to decompose potassium iodide. In this manner ether may be purified from hydrogen peroxide, aldehyd, and water. Borrigter finds more hydrogen peroxide in ether which has been kept in bottles with glass stoppers than in such as have been corked.

* *Journ. Chem. Soc.*, 1883, pp. 365 and 368.
† *Journ. Chem. Soc.*, 1883, 368.

NOTICES OF BOOKS.

Outlines of Organic Chemistry. By H. FORSTER MORLEY, D.Sc. London: J. and A. Churchill.

THIS work takes a higher aim than the chemical text-books and "manualettes" which have of late years become so alarmingly numerous. We notice, in the first place, with much pleasure, that the author is not enamoured of the examinational system which at present dominates our schools and colleges. He writes in his Preface:—"The requirements of students working for examinations have, unfortunately, compelled some departure from the plan which seems to me most suitable for teaching, because it was necessary that the book should include every substance upon which a student might expect to be examined." He also expresses the opinion—a perfectly correct one unless we are much mistaken—"that it is desirable for the beginner to go through a short course of 'preparations,' although they are not encouraged by our examination system." The strings of questions and the collections of examination papers which figure so largely in many of our chemical text-books are here happily wanting.

Concerning the methods of teaching chemistry Dr. Morley lays down, in the main, very sound principles. He criticises the usual arrangement of books on Organic Chemistry. This arrangement he characterises as "didactic and deductive: a preliminary chapter on formulæ and classification, with general descriptions of the various kinds of reaction, is followed by chapters exhibiting special cases of these general laws. But it ought not to be supposed that the student is acquainted with the properties of a score or two of organic substances of which he has never heard the names." This method he further denounces as unscientific. "Chemistry is an experimental and inductive science, not to be studied like Euclid." Our national misfortune is that, until lately, the teaching not merely of chemistry, but of all the natural and experimental sciences, has been entrusted to men who have merely a book-knowledge of the subjects. Even yet we fear it would be possible to discover schools where the attempt is made to teach chemistry and physics without apparatus. Some years back we had occasion to mention the case of two students (?) who had taken honours, the one in chemistry and the other in physiology. The former had never even cleaned out a test-tube, and the latter had never looked through a microscope.

A second method, which the author pronounces scientific and excellent, is to begin with the description of things well known, such as sugar, starch, vinegar, &c., and after the study of these proceed to examine the various products which can be derived from them. This method we should like to see fully developed.

He adopts, however, a third method. He undertakes "to describe compounds in the order in which they may be synthetically produced, so that each compound should be a product of the one before and a producer of the one after." His reason for adopting this order is his belief that "a correct appreciation of structural formulæ, and the power to judge whether a given formula be correct or incorrect, is essential if chemical industry is to make any headway in England. The dogmatic teaching of structural formulæ has turned the hearts of many chemists altogether; the result has been that original research has ceased for want of original ideas, and the decline of chemical industry is the result."

This is certainly a novel way of accounting for the relative paucity of chemical investigations in England, and for the decay of our chemical manufactures, and one to which we are by no means prepared to give an unqualified assent. In our opinion the mischief has several sources. Perhaps the main one is that original ideas and original research count for nothing at the repeated examinations for which the English student has to be ever and anon preparing, and are therefore neglected in favour of something which will "tell." We have always been of opinion that in a multitude of English chemical text-books, and in the teachings of certain colleges, structural formulæ have played a very prominent part, but the harvest of research has been by no means proportionate.

Dr. Morley insists upon a truth much overlooked. He remarks that chemical substances do not form a chain, but a tree, and that it is hence impossible to arrange them in a linear series.

Our general impression of this work is decidedly favourable, and we believe that it will be found very useful to students; but, until we dethrone the tyrant Examinationism, the ablest professors, the best manuals, and the most ample appliances will not suffice to place us in the van of scientific progress.

CORRESPONDENCE.

MILK-ANALYSIS.

To the Editor of the Chemical News.

SIR,—In issuing a second edition of my "Treatise on Milk-Analysis," I feel called upon to make known my views on the present condition of milk-analysis in this country, and as one of my earliest papers on the subject was published in the CHEMICAL NEWS about fourteen years ago, I send you my present contribution.

In constructing a system of milk-analysis, I was mindful that milk is a complex organic fluid, and that its constituents must be fragile, and that in submitting it to analytical processes there was the danger of setting up decomposition.

When I sought to obtain the total milk-solids by the process of evaporating off the water and drying the residue, it was necessary to guard against mistaking the actual water existing in the milk for water which might arise as a decomposition product. Under the influence of this idea I was led to seek the quickest way of obtaining the total solids, and found that a three hours' exposure to a temperature of 100° C. in a suitable platinum vessel, will deprive 5 grms. of milk of all its water, and reduce it to the condition of dry milk-solids. Very numerous experiments warrant me in asserting that the total milk-solids obtained in that manner are a constant quantity, which, in point of constancy, will challenge comparison with the best constants in analytical chemistry. My system of milk-analysis is based upon this constant, and rests on it as on a rock.

For some years milk-analysis, very much in the form in which I had cast it, was much practised in this country, and has been resorted to in the proceedings under the Acts for the suppression of the adulteration of food.

Many attempts have been made to discredit it, especially within the last four years; and its author, as is notorious, has, for the most part, abstained from taking any part in the discussions which have arisen.

There are two chief causes why, just at the present time, milk-analysis has declined in public estimation. One of these causes is that those analysts who practise it have not adhered with sufficient closeness to the details of the method as laid down by its author. The other cause is the appointment of the authorities of Somerset House as a sort of court of reference in cases arising under the Sale of Food and Drugs Act.

According to the directions given in the "Treatise," a milk-residue is to be obtained by drying up 5 grms., or 5 c.c. of milk, for three hours; and I lay particular stress on the full time being allowed. In the pages of *The Analyst* for the year 1882, Mr. Hehner describes the method to consist in drying 5 grms. of the milk for two and a half to three hours. Sometimes analysts alter the

scale, taking 10 grms. instead of 5 grms. for the solid residue; and even the temperature of drying has been altered—instead of 100° C., I have known 110° C. to be employed. The substitution of the water-oven for the water-bath is sometimes made.

I disapprove of all these alterations, and have to remark that, under such treatment, discrepancies are inevitable.

In my treatise "the solids not fat" are arrived at by the arithmetical operation of subtracting the quantity of fat from the quantity of total solids. It may seem a small point—to insist upon that manner of arriving at the "solids not fat" in preference to the direct operation of weighing the "solids not fat;" but I believe that much uncertainty has arisen from the substitution of the direct for the indirect measurement of "solids not fat."

With regard to the determination of the fat, I do not see any reason to alter the method laid down in my book; and I would make the remark, that the extra 0·2 per cent of fat with which the employment of the Soxhlet apparatus is credited, may possibly be a product arising from the metamorphosis of the caseine.

In constructing the system of milk-analysis, I had before my eyes the necessity that the system should be practicable as well as logically consistent. I felt, too, that simplicity and rapidity of execution would commend it. That it is simple beyond compare and that it is quick is a matter of common knowledge.

In three and a half hours a good operator is able to make the whole analysis, and fill up the following form:—

In 100 c.c. of milk—

	Grammes.
Total solids	$= x$
„ fat	$= y$
Solids not fat (calculated)	$= x - y$
Ash	$= z$

In reading the criticisms of the milk-analysis—I hope I may be pardoned for saying so—I have been amused. My critics appear to imagine that milk is a fluid of simple composition, and that in point of simplicity it resembles an aqueous solution of two or three simple mineral salts; and appear to regard paying attention to the complexity of milk as an unscientific procedure. My critics, who look upon milk as a comparatively simple fluid, recommend complicated and tedious analytical processes which they say are scientific. I, who hold that the composition of milk is pre-emiently complex, resort to the simplest of analytical methods.

The various suggestions which have been made for the modification of milk-analysis—the suggestion to dry for six hours instead of for three or three and a half hours; the suggestion to mix the milk with sand, or to spread it out on blotting-paper; the suggestion to submit the "solids not fat" to two dryings instead of one; the suggestion to resort to the Soxhlet digestion with ether, instead of the simpler treatment; all these suggestions tend in one direction, viz., towards the destruction of the "solids not fat," which when milk analysis left my hands fourteen years ago, were shielded from all harm with most zealous care. The adoption of these suggestions at once lowers the milk standard from 9·3 to 8·5; and the principles which dictate the adoption of these suggestions degraded milk-analysis to the condition in which I found it before the year 1871.—I am, &c.,

J. Alfred Wanklyn.

London, January 25, 1886.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Being one of those who have passed the examination for the A.I.C., I should like to say something about it from our point of view. As probably will be expected, I am entirely opposed to persons being admitted simply on evidence of fitness. I fail entirely to see then what difference there would be between the Institute and the Chemical Society. It is well known that in the latter there are a fair number who, from the amount of their knowledge of chemistry, ought never to be there. Moreover, if the Institute intend to apply for powers to make the Associateship a necessary qualification for practising as an analytical chemist, I think they will find that the authorities will scarcely like the idea of "evidence of fitness."

But, whilst completely opposed to this, I think that the condition of having had a three years' college course, and having passed examinations in that college, might with great advantage be abolished. It might perhaps be replaced by requiring three years at a college, or with an analytical chemist of known standing, as suggested at the meeting in Manchester. But if this was done it seems to me that there must be added some kind of theoretical examination. Probably the best way would be to make it a condition that the candidate for the practical examination should present certificates of having passed in certain subjects of the Science and Art Examinations, and having attained a certain standard in them, the subjects and standard being of course fixed by the Council. These examinations are held in so many places all over the country, and the fees are so small, that it would not be difficult for anybody to take them.

Besides this, however, the practical examination needs a thorough reform in its system. The present method is that each of the local examiners sets what he pleases, and himself examines the papers. Now under these circumstances it is impossible that the candidates at the different places should be treated alike, for examiners, like other people, are human, and differ very much in the standard they expect, and what some reckon trifling errors others reckon great blunders. Moreover, some set a much more difficult examination than others, which of course tells greatly. The analyses, &c., to be made ought to be decided by the whole of the examiners together, the same things given all over, and when finished the papers should be examined by two or three of these examiners, and a list published of the successful candidates. If this were done there would, I expect, be less complaining about the practical examination.

At the same time it is to be hoped that, if anything of this kind be adopted, the examiners will not fall into the error so frequent among examiners, now-a-days, of giving a stiff catch examination. The reason a great many people are getting disgusted with the examination system is because so many of the papers, at the present time, are set to find out, not what the candidates know, but what they *do not* know. I am quite sure that it is a far fairer test of knowledge to give a comparatively easy paper, and then, of course, expect a somewhat higher standard.—I am, &c.,

Cyclops.

THE INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I sincerely trust that the Council of the Institute of Chemistry will not decide upon the retrograde, and probably suicidal, step of abolishing the entrance examination;—a step which would be extremely unfair to those Fellows of the Institute who waited until the present examination became a *sine qud non* for admission, in the belief that the value of a qualification obtained by examination is far higher than that of a title procured without any real test of ability whatever, and that, in future, the qualification of F.I.C. would only be obtainable by examination. Abolition of the examination would roughly undeceive these Fellows, who in such a case would, I think, do well to agitate for the return of their entrance-fees and subscriptions.

Such a step would at one blow destroy the *raison d'être* of the only Association which has done anything in the

direction of giving professional chemists a more definite position than they have hitherto occupied. In writing thus I have not forgotten the existence of the Society of Public Analysts, which, excellent in its way, does *not* supply what is wanted.

An officially recognised Examining Body, whose diploma shall be required by Law to have been obtained by every man desirous of practising as a consulting and analytical chemist. This is our urgent requirement. Lawyers, physicians, surgeons, and even drug-sellers, have to undergo examinations: why should professional chemists be, in this respect, upon a lower level? As things are at present there is nothing whatever to prevent any linen-draper's assistant, merchant's clerk, or grocer's shop-boy from setting up in practice as an analytical chemist.

By making an examination an indispensable condition of admission to Fellowship after the first 36 months, the Institute of Chemistry took a step in the right direction, though much yet remains to be done. Surely it would be madness for the Council to undo the work performed. Let them rather strain every nerve to procure an Act of Parliament. This, however, would certainly not be facilitated by doing away with the crucial test to which candidates for admission to Fellowship now have to submit themselves.

The feebleness of the arguments brought forward in favour of the abolition of this test of ability is really amazing. Does it not appear as if those who don't belong to the Institute, and wish to, desire to shirk the examination? Perhaps this is a feeling common to all who have an ordeal of this kind looming in the future.

It is somewhat curious that so much has been said about the time occupied in preparing for and submitting to the examination. *Of course* an examination takes up a few days, and the loss of nearly a week may be no small matter to a young practitioner. Still what one can do, another should be able to manage; and the qualification, *so long as it is procurable only by the severe test of a stiff examination*, is decidedly worth a little trouble and expenditure of time.

One of your correspondents referred to the Institute of Civil Engineers. That is undeniably a fine institution, but its existence does prevent the possibility of a man who has not had a day's training in his life sticking "C.E." after his name, and setting up in practice as a civil engineer. This kind of thing, whether among engineers or among chemists, should not be possible; and the much maligned and scoffed at Institute of Chemistry has, so far, worked in the direction of putting an end to such a condition of affairs among chemists. Let us hope that its Council, in place of making the great mistake of annulling all its past work, will strive to reach the goal which is so desirable and necessary, for the sake of all practising professional chemists.—I am, &c.,

E. F. M.

MICROSCOPIC WRITING.

To the Editor of the Chemical News.

Sir,—Our attention has been called to a statement made in your paper, when reporting a meeting of the Manchester Literary and Philosophical Society (Chemical News, vol. liii., p. 33), that Mr. Webb, who exhibited the microscopical writing-machine at the Exhibition of 1862, died some ten or fifteen years since. We should be very much obliged, therefore, if in your next issue you would contradict this statement, as Mr. Webb is still alive, and continues to do for us these remarkable microscopic writings, which we are continually selling; and if any of your readers wish to have any further information about them we shall be pleased to supply it on their communicating with us. The announcement of Mr. Webb's death is calculated to injure both him and ourselves if left to stand uncorrected.—We are, &c.,

W. Watson & Sons.

313, High Holborn, London, W.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 3, January 18, 1886.

Electric Spectrum peculiar to the Rare Earths of the Terbium Group.—Lecoq de Boisbaudran.—See p. 63.

Considerations relating to the Electric Illumination of Lighthouses.—F. Lucas.—The author points out the defects of the arc-light and recommends an incandescence lamp with a special modification for the absorption of traces of oxygen remaining in the glass globe.

The Active Principle of the Comma Bacillus, regarded as the Cause of Death and of Immunity.—J. Ferran and I. Pauli.—The authors infer from four series of experiments on guinea-pigs that the comma bacillus when dead confers an immunity which enables animals to resist the effects of the living bacillus. The active principle of the bacillus, insolated by known methods, confers an immunity which enables the animal to resist the effects of the living microbion, and *vice versa*. According to these authors the cause which determines immunity and the cause which induces death are one and the same, essentially chemical in their nature. Hence immunity is merely a case of habituation which may be obtained by purely chemical agents.

Lengths of Undulations hitherto not recognised.—M. Langley.—Until a very recent date the limits of the known spectra from all sources, celestial or terrestrial, were from 2000 to about 10,000 of Angström's scale, that is from 0·0002 to 0·0010 m.m., and even last year an authority no less competent than M. Becquerel maintained that the most extreme radiations whose existence had been experimentally demonstrated did not reach a wave-length of more than 0·0015 m.m. The author's researches have extended to the sources of heat comprised between 100° and −2°, the latter radiating upon bodies still colder. The smallest value corresponding to the maximum heat in the spectrum of melting ice is in all cases greater than 50,000 of Angström's scale. The radiations whose lower limit Newton found at 0·0007 m.m. have been extended to 0·0150 m.m., that is to more than twenty times Newton's limit, so that the great gap which existed between the lowest known vibration of light and the highest known vibration of sound has been in part filled up.

Action of Antimony Sulphide upon Potassium Sulphide.—A. Ditte.—If hydrated antimony sulphide is treated with a strong solution of potassium monosulphide much of the former is dissolved, and the liquid, if evaporated in the presence of an excess of alkaline sulphide, deposits large octahedral transparent crystals of a pale yellow—$2KS,SbS_3$. Cold water splits them up, giving an orange deposit and dissolving potassium sulphide. If a weaker solution of potassium sulphide is saturated with antimony sulphide the above crystals no longer appear, but in their stead a compound less rich in alkaline sulphide and sparingly soluble in water. This solution on evaporation *in vacuo* forms light red prismatic crystals easily affected by light.

A New Synthesis of an Inactive Borneol.—G. Bouchardat and J. Lafont.—The authors have effected this synthesis by setting out from terebene or inactive camphene, which they have transformed by the direct fixation of an organic acid into a borneol ether. The latter on saponification yields the inactive borneol in question.

January 25, 1886.

Observations relating to M. Langley's Paper on Wave-lengths hitherto not recognised.—H. Becquerel.—In the *Comptes Rendus* of January 18th occurs a

paper by M. Langley, who ascribes to the author a statement that "the most extreme radiations whose existence has been experimentally demonstrated do not reach a wave-length exceeding 0·0015 m.m." M. Becquerel has never put forward such an opinion, for the limit at which observations come to a stop depends essentially on the nature and the sensitiveness of the methods employed to show the presence of the invisible ultra-red radiations. In the *Comptes Rendus* for September 1st, 1884, he gave lengths of the principal rays and bands of the ultra-red solar spectrum, determined by means of a grating, as far as 0·001880 m.m., numbers which agree with those given by M. Langley for the same regions. The method of observation founded on the phenomena of phosphorescence does not yet enable us to reach as far as does M. Langley's bolometer, but within the limit indicated above it gives a much greater delicacy of details.

Transfer of Copper through a Gaseous Stratum, and the Direct Combination of Copper and Nitrogen.—R. Blondlot.—This paper will be inserted at some length.

On Certain Properties of Antimony Sulphide.—A. Ditte.—The double potassium and antimony sulphides described in the author's recent paper may also be obtained with anhydrous antimony sulphide. Between antimony chloride and hydrogen sulphide on one side, and antimony sulphide and hydrochloric acid on the other, there are produced inverse and reciprocal actions giving rise to chloro-sulphides, hydrochlorates, &c.

Reagent for Detecting the Acid Function of Feeble Acids.—R. Engel.—This paper will be inserted in full.

Composition of Wine-Brandies.—Ch. Ordonneau. In true brandies distilled from grape-juice the author finds normal butylic acid present. In the alcohols of grain, beet-root, and potatoes, instead of butylic acid there is found the isobutylic, without a trace of normal butylic acid. This isobutylic acid, the cause of the disagreeable odour and taste of these alcohols, is not formed if fermentation is affected by the elliptical ferment of wine, whilst it is always present if beer-yeast is employed.

Journal für Praktische Chemie.
New Series, Vol. xxxii., Part 11.

Researches from the Chemical Laboratory of the University of Kasan.—This consists of the conclusion of a paper by J. Kanonnikoff, on the refractive power of chemical compounds.

Magnetic Circular Polarisation of Compounds in Relation to their Chemical Constitution, with Remarks on the Preparation and Specific Gravity of the Bodies examined (conclusion).—W. H. Perkin.—This extensive memoir, which is illustrated with a number of diagrams, does not admit of useful abstraction.

On Triphenyl-acetic Acid.—K. Elbs and E. Tölle.—The authors describe the salts of this acid, its sulphonation, its oxidation, and the by-products of the action of trichloracetic acid upon benzol in the presence of aluminium chloride.

On a Dimethyl-naphtho-chinoline.—J. Hastings Reed.—The compound in question, $C_{15}H_{13}N$, is a white, crystalline body, readily soluble in alcohol and ether, fusible at 126° to 127°, and volatile at above 360°.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 1, 1886.

A Bead Tube for the Absorption of Gases.—A. Emmerling.—(*Chemiker Zeitung.*)

Sulphuric Acid Bath.—A. Kalesinsky.—All these three papers require the accompanying figures.

Cutting Thick Glass Tubes.—An anonymous writer in *La Nature* wraps round the tube an iron wire of 0·5 m.m. in thickness, introduces it into an electric current of sufficient strength to ignite the wire, and drops a little water uhon the glass by the wire.

Air-tight Corks.—An anonymous writer in the *Chemiker Zeitung* proposes to soak them for some hours in a solution of 15 grms. gelatin and 24 grms. glycerin in ½ litre of water at 44° to 48° and then to dry them. If they are to resist acids they are introduced into a mixture of 2 parts vaseline and 7 parts paraffin at 40°.

Reagent for Alkaline Substances.—Otto Schweissinger (*Chem. Central-Blatt.*)—Two drops of "iodised tincture of galls" (the preparation of which is not given) give a transitory rose colour with all alkalies and alkaline earths, their carbonates, bicarbonates, borates, and phosphates, if soluble in water. In this manner 1 part potassium carbonate can be recognised in 100,000 parts of water.

Development of Hydrogen Sulphide.—Kübel (*Archiv der Pharmacie*)—When hydrogen sulphide is only required at intervals the author washes the iron sulphide, after use, with water, and preserves it under a stratum of glycerin.

Production of Hydrobromic Acid.—Ad. Sommer.—From the *Journal of Society of Chem. Industry.*

Quantitative Analysis by Electrolysis.—Alex. Classen and others.—The notes will be reproduced at some length.

The Gravimetric Determination of Manganese.—C. Holthoff and C. Reinhardt.—A discussion on Wolff's method of separating manganese from lime and magnesia.

Determination of Sulphurous Acid in its Combinations.—W. B. Giles and A. Shearer.—From the *Journal Soc. Chem. Industry.*

Determination of Bromine in presence of Excess of Chlorine.—A. Cavazzi (*Gazetta Chimica* and *Chemiker Zeitung.*—Already noticed.

Formation of Chloroform Hydrate.—G. Chancel and F. Parmentier.—From the *Comptes Rendus.*

Distinction between Ortho-, Para-, and Meta-diamines.—E. Lellmann.—From *Liebig's Annalen.*

Determination of Halogens in Organic Substances.—C. Zulkowski and C. Lepèz (*Monaths' Hefte f. Chemie*).—An improvement upon the author's method (vol. xxiv., p. 605) of effecting combustion with oxygen in presence of platinised quartz.

Determination of Tannin.—C. Councler and J. von Schrœder.—The report of a commission for revising Löwenthal's process. The principal results will appear at the earliest opportunity.

Proportion of Alcohol to Glycerin in Beer.—E. Egger.—The author finds that Borgmann's method devised for sweet wines is also available for the analysis of beers.

Examination of Sugar.—A. Vogel (*Bayr. Industrie u. Gewerb-Blatt*).—According to the author beet-sugar (betose) can be distinguished from cane-sugar (true saccharose) by a trace of nitric acid, demonstrable by means of indigo or diphenylamine, as well as by a quantity of ammonia, determinable by the Nessler test. Practical men have observed that a solution of beet-sugar coloured with extract of indigo is decolourised on evaporation, which is not the case with cane-sugar.

Detection of an Admixture of Anhydrous Glucose in Cane-Sugar.—P. Casamajor.—From the CHEMICAL NEWS.

Adulteration of Pepper.—C. Neuss (*Pharm. Zeitung*).—If ground pepper is covered with strong hydrochloric acid all the particles, save the small blackish fragments of the shell, take an intense yellow colour. The editor remarks that certain other liquefied vegetable tissues take a yellow colour with hydrochloric acid.

Determination of the Value of Zinc Powder by the Hydrogen evolved with Acids.—H. N. Morse.—This illustrated paper is taken from the *American Chemical Journal* (vii., 1).

Flux for opening up Basic Silver Ores.—Stone.—The author uses a mixture of 9 parts soda, 3 parts borax, 1 part tartar, and uses two parts of this mixture to one part of ore. If sulphur is present a few iron nails are added.

Testing Papers.—W. Herzberg.—The author determines the resisting power of the paper with Hartig-Reusch's apparatus. Afterwards a portion of the paper, well-boiled in a flask, is submitted to a microscopical and chemical examination.

Determination of Nitrates in Human Urine.—Th. Weyl and Citron.—The authors use Schulze's method.

Apparatus for determining Urea with Sodium Hypobromite.—Ch. Doremus (*Journ. Amer. Chem. Soc.*) and G. Lunge (*Archiv f. Physiologie Pfluger*).—This paper requires the accompanying illustrations.

Detection of Blood.—Bufalini (*Ann. di Chim. Med. Pharm.*).—The blood or the watery extract of the spot is treated with a drop of tincture of iodine and a very little acetic acid. A drop of this mixture is placed upon a port-object and is repeatedly passed through a flame, whilst 8 to 10 drops of acetic acid are gradually added with a fine pipette. In this manner crystals of iodhæmine are obtained with absolute certainty in one to two minutes.

The Variation of Atomic Weights.—E. Vogel (*La Nature*).—From the circumstance that the atomic weights deduced from certain combinations regularly vary a little from those obtained from other compounds of the same element the author infers that the value of the atomic weights is variable according to certain laws. Dr. W. Fresenius suggests that such variations may be due to a constant analytical error which does not occur in case of other compounds.

Atomic Weight of Cerium.—H. Robinson.—From the CHEMICAL NEWS.

Determination of Manganese in Iron and Iron Ores.—W. Mathesius (*Chemiker Zeitung*).—The author dissolves in hydrochloric acid, oxidises the solution with bromine, and, if necessary, evaporates to dryness on the water-bath in order to eliminate silica. After re-dissolving in hydrochloric acid the whole without filtration is rinsed into a litre flask, almost neutralised with ammonia, and then mixed with an excess of zinc oxide suspended in water. The flask is then filled up to the mark with water, the contents are mixed, and half a litre is filtered through a folded filter. This portion is then mixed with a rather large quantity of quite pure ammonium chloride, then with a large excess of ammonia, and the manganese is thrown down by Wolff's method. The manganese is deposited completely and free from zinc. The precipitate of hydrated manganese peroxide is very carefully washed with ammoniacal ammonium chloride. The filter is primed with the same liquid to prevent zinc from being deposited on the fibres of the paper, which is not readily re-dissolved. Finally, to remove ammonium chloride, the filter is repeatedly washed with hot water, as otherwise a considerable loss of manganese takes place on ignition.

Detection of Morphine in Urine.—Notta and Lugan (*Journal de Pharmacie d'Anvers*).—The authors precipitate 1 litre of the sample with 100 c.c. basic lead acetate, filter, and remove excess of lead with sulphuric acid (1 : 10). The filtrate is supersaturated with ammonia and shaken up for a few minutes with 100 c.c. of hot amylic alcohol. The latter is then drawn off by means of a pipette and the morphine is transferred first to water acidulated with sulphuric acid, and from this again, after supersaturation with ammonia, to a fresh portion of amylic alcohol. The residue on evaporation is pure morphine, as may be found by the characteristic reactions.

NOTES AND QUERIES.

**** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Utilisation of an Iron Ore.—Can any of your readers inform me if an ore containing 55 per cent iron, 17 per cent silica, and 3½ per cent alumina can be utilised?—G.

MEETINGS FOR THE WEEK.

MONDAY, 8th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Friction," by Prof. H. S. Hele Shaw.
TUESDAY, 9th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8. (Anniversary).
—— Royal Institution, 3. "Naucratis," by R. Stuart Poole, LL.D.
WEDNESDAY, 10th.—Society of Arts, 8. "Mining Industry at the Buda-Pest Exhibition," by Bennett H. Brough.
—— Geological, 8.
—— Microscopical, 8. (Anniversary).
—— Pharmaceutical, 8.
THURSDAY, 11th.—Royal, 4.30.
—— London Institution 7.
—— Royal Institution, 3. "Metals as affected by Small Quantities of Impurity," by Prof. W. Chandler Roberts-Austen, F.R.S.
—— Philosophical Club, 6.30.
—— Mathematical, 8.
FRIDAY, 12th.—Royal Institution, 9. "Experiments showing Dilatancy, a Property of Granular Material, possibly connected with Gravitation," by Prof. Osborne Reynolds, F.R.S.
—— Astronomical, 3. (Anniversary).
—— Quekett Club, 8.
SATURDAY, 13th.—Royal Institution, 3. "The History of Volcanic Action in the British Isles," by Archibald Geikie, LL.D., F.R.S.
—— Physical, 3. Annual General Meeting. "On Experimental Error in Calorimetrical Work; and on Delicate Calorimetrical Thermometers," by Prof. U. S. Pickering.

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SELECT METHODS IN CHEMICAL ANALYSIS (CHIEFLY INORGANIC).

BY

WILLIAM CROOKES, F.R.S., V.P.C.S.,

EDITOR OF "THE CHEMICAL NEWS."

LONDON: LONGMANS, GREEN, & CO.

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THE CHEMICAL NEWS.

VOL. LIII. No. 1368.

ON RADIANT MATTER SPECTROSCOPY: NOTE ON THE SPECTRA OF ERBIA.*

By WILLIAM CROOKES, F.R.S.

I HAVE recently succeeded in getting the earth erbia in a sufficiently pure state to allow me to examine its phosphorescent spectrum without the interference which might be produced by the presence of yttria, samaria, bolmia, thulia, Yα, or ytterbia. As in the case of yttria† the spectrum is best seen when erbic sulphate is heated to redness and submitted to the electric discharge in a high vacuum. The addition of calcic sulphate interferes with the purity of the spectrum. In this respect erbia differs from samaria, as the latter earth seems to require the presence of some other metal to develope its phosphorescent properties.

The phosphorescent spectrum of erbia consists of four green bands, of which the following measurements have been taken:—

Scale of spectroscope.	λ.	$\frac{1}{\lambda^2}$.	Remarks.
9°·750	5564	3230	Approximate centre of a wide band, shading off at each side.
9°·650	5450	3367	Approximate centre of a band, narrower and somewhat fainter than the first band.
9°·525	5318	3536	Approximate centre of a narrow band, bright and moderately sharp on each side.
9°·400	5197	3702	Approximate centre of a band, similar in appearance to the first band, but brighter.

Fig. 1 shows the erbia phosphorescent spectrum drawn to the $\frac{1}{\lambda^2}$ scale.

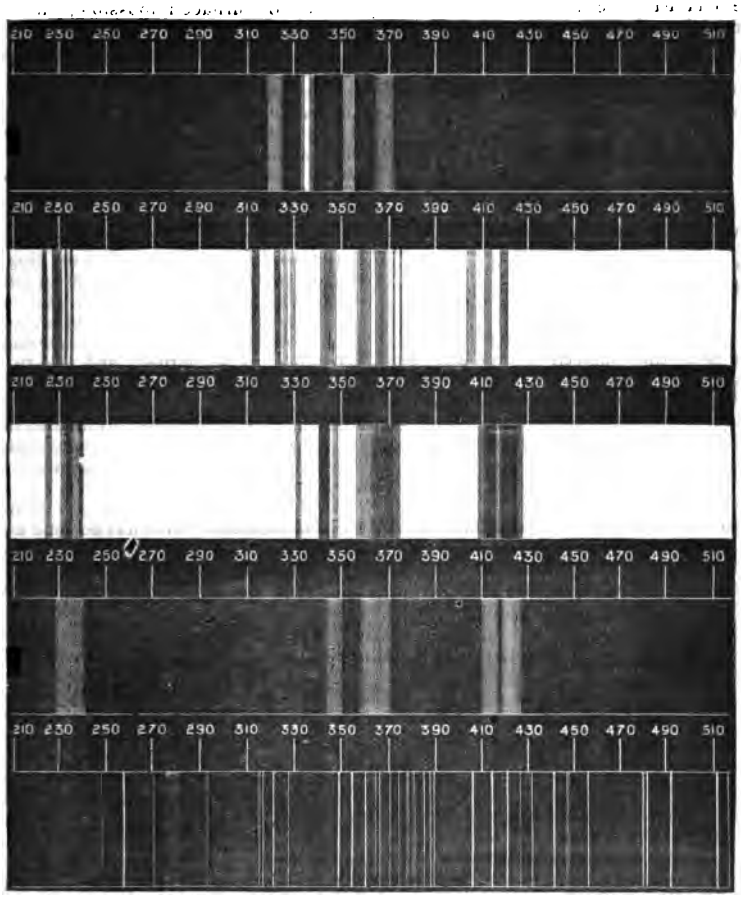

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

These bands do not correspond in position to any in either the yttrium or samarium spectrum. The nearest approach to a coincidence is between the first erbia green and the samarium green, but when the two spectra are examined one over the other it is seen that the samarium band is less refrangible than the erbium band.

The first green of Yα occurs midway between the first and second greens of erbia, and the second Yα green comes between the second and third erbia greens.

Pure erbia is of a beautiful rose-pink colour. When illuminated by sun or electric light and examined in the spectroscope it gives a spectrum of black lines and bands as sharp and distinct as the Frauenhofer lines. Fig. 2 shows the erbia spectrum by reflection. It is strange that

* A Paper read before the Royal Society, January 21, 1886.
† *Phil. Trans.*, Part III., 1883, p. 913 (par. 71).

this most characteristic property has been recorded by so few observers. Indeed, the only notice of it I have come across is a passing remark of Professor Clève's that "the light reflected by dry erbia shows absorption-bands."

Fig. 3 shows the absorption spectrum given by a solution of pure erbic chloride. It differs in some respects from the drawings mapped from older observations, as the absorption lines of holmia and thulia are absent. The fine group of lines in the green of the reflection spectrum is also absent in the absorption spectrum.

The spectrum of bright lines emitted when erbia is rendered incandescent in the blowpipe flame has been often observed, but the lines in this case are luminous on a fainter continuous background and are not particularly sharp, whilst the reflection spectrum consists of black lines sharply defined on a continuous spectrum.

The spectrum emitted by incandescent erbia is shown in Fig. 4.

Fig. 5 shows the characteristic lines in the spark spectrum of erbium, taken from a concentrated acid solution of erbic chloride, with a Leyden jar in a shunt circuit.

I have thought it advisable to give these five spectra of erbium, as they show how entirely different the phosphorescent spectrum is to any other spectrum given by this element.

ON THE ESTIMATION OF NITROGEN BY COMBUSTION.

By GEORGE STILLINGFLEET JOHNSON and ARNOLD EILOART, B.Sc.

MUCH has been recently written, and some work has been done, in connection with this subject, mainly with the object of suggesting improvements in the methods hitherto employed for the quantitative determination of nitrogen; partly, also, for the purpose of comparing results obtained by the two important processes introduced by Will and Varrentrapp, and by Dumas respectively.

In spite of certain statements which have been recently made to the contrary, few chemists who have worked both methods will deny that the process of Dumas is far more generally applicable than the soda-lime method. One of the outcomes of recent work with the latter process has been the addition to the soda-lime, hitherto exclusively used for estimating nitrogen as ammonia, of sodium thiosulphate, sodium acetate, or both, with the expressed object of supplying more hydrogen to the nitrogen, and thus facilitating its conversion into ammonia. This important modification of the process of Will and Varrentrapp reveals misgivings in the minds of its introducers as to the universal efficacy of the unmodified soda-lime method. It remains to be seen whether the improvements proposed will eventually extend the limits of applicability of the ammonia process to all substances.

At present, however, there are certain cases in which the soda-lime method is not available, or in which at least it can be employed only with unusual precautions; such a case is the estimation of nitrogen in coal, or the analysis of any nitrogenous compound which yields much tarry matter when submitted to destructive distillation. For the analysis of such substances the process of Dumas is certainly to be preferred.

The introduction of the Boat-method of combustion in Dumas's process has been a great improvement. Not only does this modification of the method enable us to heat the copper oxide and metallic copper in front of the tube to redness in a current of pure CO_2 before commencing the combustion, thereby vastly shortening the time required to completely expel atmospheric nitrogen from the tube and its contents, but it also renders practicable an examination of the *ash* of the substance, which is often of great importance.

One of us (CHEMICAL NEWS, vol. l., p. 191) has described such a modification of the method of Dumas, whereby also some insight may be gained as to the condition of the nitrogen in the compound under analysis, the gas evolved being collected in two portions, viz.—1st, that which escapes during the destructive distillation of the substance in CO_2; and 2nd, that which is collected whilst nitrogenous carbon, left in the boat at the close of the first stage, is undergoing combustion in oxygen, the source of this oxygen being potassium chlorate, placed in a fused condition at the back of the combustion-tube.

This process has been much used in the chemical laboratory of King's College, London, during the past year, and one object of the present communication is to describe certain improvements which have suggested themselves as results of practical experience with it.

We still employ a combustion-tube drawn out in front so as to form a delivery-tube, as at first suggested by one of us. This renders loss of gas in front of the combustion-furnace impossible, and has been found most convenient.

The metallic copper and granulated copper oxide are also retained as usual.

Instead, however, of introducing the substance under analysis into the same boat with the potassium chlorate, it was soon found more convenient to use two boats,—one for the nitrogenous substance, with a clear space of about 1 inch between it and the copper oxide; and a second for the potassium chlorate, 2 inches behind the first boat. Ignited asbestos is placed between the boats, to prevent contamination of the ash of the substance with fused KCl. The asbestos plug must not be too tightly packed, or it may create an obstruction when saturated with potassium chloride. These intervals between the boats and copper oxide enable the analyst to heat the whole of the oxide in pure CO_2 without endangering the substance to be burned, and also to expel the whole of the first portion of nitrogen from the substance without any risk of evolution of oxygen from the potassium chlorate. It has also been found advisable to collect the two portions of nitrogen in two separate measuring-tubes, in case it be desired to estimate their relative proportions accurately.

As soon as the volume of gas above the potash-ley in the first measuring tube has become constant,—no oxygen having been as yet evolved from the chlorate,—the tube containing the gas is removed, and a similar one placed over the end of the delivering combustion-tube in the mercury-trough. The potassium chlorate is then heated until sufficient oxygen has escaped to burn away the carbon in the boat and to re-oxidise the reduced copper adjacent to the boat,—a process which is easily traced by watching the glowing metal, whose temperature is raised considerably above that of the neighbouring copper oxide during its oxidation. As soon as the glow ceases, or if at any time the metallic copper in front of the combustion-tube shows signs of oxidation, the evolution of oxygen is at once arrested by removing the heat from the potassium chlorate. The behaviour of the chlorate at this stage of the process is all that could be desired. The evolution of gas is steady and easily controlled, and explosions never occur, since all combustible gases have been expelled from the tube during the first stage of the process—that, namely, of destructive distillation. After the chlorate has ceased to evolve gas, the passage of the CO_2, which passes from a Kipp's constant-generating apparatus throughout the process, is continued until the volume of the gas above the potash-ley in the second measuring-tube remains unchanged.

If the gas is measured over water it is necessary to employ boiled water for the purpose, since the potash-ley is heated by the furnace and by the absorption of CO_2, and therefore rapidly liberates any gas which may be in solution in the water.

As regards the *quantity* of potassium chlorate necessary for a combustion it has been found that, in the case of coal, ten times the weight of coal taken is sufficient,

whilst with most substances three times their weight of chlorate is ample.

Further observations have confirmed the statements made by one of us a year ago, that different nitrogenous compounds vary greatly as to the proportion of their nitrogen which escapes during destructive distillation, and also that the ratio between the two portions of nitrogen is simple and constant in each compound.

The next development was the performance of more than one determination in the same operation. Two boats, both as short as possible, and each containing a weighed portion of the substance or substances to be analysed, are placed between the copper oxide and the potassium chlorate. The front boat is of platinum, in order that its contents may readily become heated. The second boat is of porcelain, in order that its contents may not become heated too rapidly. Its distance from the first will depend on the temperature its contents will bear without decomposition; but if the interval be 3 inches it may be kept below 80° C., when the tube around the first boat is at a full red-heat. The boat for the chlorate is also preferably of platinum. Four inches of tube, partly filled with ignited asbestos, should intervene between the chlorate and the cork. When the tube cools, the asbestos plugs and the chlorate boat, now held to the tube by fused potassium chloride, must be loosened by soaking in water into which the end of the tube is dipped at a slight incline. The ash may then be weighed and examined.

As this process of cooling and extracting the chlorate-boat must be performed after each combustion, before a fresh supply of substance can be introduced between the chlorate and the copper oxide, the gain of time in performing as many determinations as possible at each operation is great, and the risk of cracking the combustion-tube by cooling and re-heating is proportionally diminished. Moreover, the air in the combustion-tube has to be expelled once only for each operation, independently of the number of determinations effected thereby. This number is of course limited by the length of the furnace, but two boats containing such a refractory substance as K_4FeCy_6 may be treated at one operation upon a 30-inch furnace.

We hope to throw some light upon the constitution of various nitrogenous compounds by a series of analyses conducted according to the process of Dumas, modified as above.

King's College, London,
February 1, 1886.

ON THE

VARIATIONS OF THE ABSORPTION-SPECTRA AND THE EMISSIVE PHOSPHORESCENCE-SPECTRA OF ONE AND THE SAME BODY.

By M. HENRI BECQUERREL.

RESEARCHES now in progress have led the author to suppose that the absorption of radiations by different substances is due to the existence of synchronous vibratory movements of the absorbed radiations,—movements which may take rise under the influence of these radiations, and which may have their seat either in the molecules of the bodies or in the intermolecular ether. In certain substances these movements give rise to phosphorescence.

This hypothesis leads to the consequence that in one and the same absorptive substance, placed in different media, the internal vibratory movements will no longer have the same rapidity, and that consequently both the absorption-spectra and the emission-epectra will be different. We may even foresee that the cause which retards the propagation of light in the interior of various media may have an influence of the same kind upon the time of the periods of the intermolecular movements, and that if we dissolve in various liquids one and the same substance presenting absorption- or phosphorescence-bands, the latter will correspond to movements so much the slower, and so much the more displaced towards the red as the indices of refraction of the solution are greater. We find thus, *à priori*, a general conclusion which has been deduced experimentally from numerous observations made by different physicists. The author has verified the generality of the fact with different substances in different solvents. Every chemical modification of the substances gives rise in the spectra to modifications which will not be examined in this paper.

The influence of the variation of the indices of refraction upon absorption is distinctly shown in solutions of one and the same body of different degrees of concentration, and observed in layers of different thickness, so that the absorption-bands always retain the same aspect. Thus for a strong solution of didymium nitrate in water, the refraction index of which corresponding to the middle of the strongest absorption-band is $n = 1{\cdot}4388$, the mean wave-length of this band is $\lambda = 579$. In the same solution diluted with water we have, for the same band, $n = 1{\cdot}3454$ and $\lambda = 574{\cdot}5$. We thus see that for solutions of different strength of one and the same body, in one and the same solvent, the absorption-bands do not occupy the same place in the spectrum, since the index of refraction varies with the concentration.

These considerations apply to crystalline media. In a double refractive crystal, giving an absorption-spectrum, the two rays have not the same indices of refraction; the absorption-spectrum corresponding to them should therefore be different, and, in this point of view, all the double refractive crystals are polychroitic. In 1866 Prof. Bunsen observed that the absorption-spectrum obtained through a crystal of didymium sulphate varies slightly if studied in polarised light according to the different directions. Mr. Sorby has since observed an analogous fact in the uraniferous zircons. At the conclusion of an investigation on the relations between absorption and dispersion, Dr. Kundt advanced the idea that in bi-refractive dichroic substances the absorption-bands of that of the two rays which has the greatest dispersion ought to be in the spectrum, nearer the red than for the other ray. Observation does not entirely agree with these views, which, as far as crystals are concerned, are not based upon direct experiment. The natural crystals in which absorption-bands have been recognised are parisite, monazite, various apatites, scheelite, and various uraniferous zircons. To this list may be added leucophane, melinophane, and the bacillary strontianite from Scotland in which the author has detected didymium. The absorption-spectra of these latter substances in natural light are composed of very fine bands, variously grouped, corresponding to the following wave-lengths:—

Scotch strontianite — 588, 584·5, 580·7, 577·5, 573·5, 570·3, 567.

Leucophane — 599, 593, 589·2, 585·5, 582, 578·2, 573·5, 528.

If we fuse leucophane the group of fine bands is replaced by diffused bands.

If we study the various crystals above-mentioned in polarised light we see the absorption-spectra change with the direction of the crystal.

Let us examine at first the phenomena presented by uniaxial birefringent crystals. We may mention as type the spectra of scheelite in which M. Cossa had detected didymium. The mean wave-lengths of the bands of the absorption-spectra are the following:—

Ordinary ray — 593 (trace), 588·5 (trace), 585 (strong trace), 579 (trace), 573·5 (strong trace).

Extraordinary ray—596, 593, 588·5, 586, 585, 579, 578, 573·5.

The other crystals give results of the same order.

We deduce from observations made in different directions that in uniaxial crystals the absorption-spectrum observed in any direction whatever is formed by the

superposition of two series of bands corresponding each to each of the principal directions of elasticity of the crystal.

The spectrum of the ordinary ray gives one of these series of bands which constitute the ordinary spectrum. For the extraordinary ray the bands displace each other only when the index varies with the direction of the ray, but the spectrum is formed by the superposition, in varying intensity, of the two series of bands just mentioned. In order to isolate completely the extraordinary spectrum the author is having crystals cut in suitable directions. In the direction of the axis the two spectra appear superposed, and only vary in intensity when the azimuth of the plane of polarisation of the light is varied.

In biaxial crystals the phenomena appear more complicated, and we may foresee the existence of three absorption spectra corresponding to the three axes of elasticity.

We may expect to find analogous variations in the phenomena of phosphorescence presented by crystals. Among phosphorescent crystals, where the author has recognised changes in the absorption-spectra, may be mentioned the salts of uranyle and in particular the double potassium-uranyle chloride, the very remarkable variations of which will be shown in a future memoir. Experiment has shown that in polarised light the phosphorescence-spectra of crystals do not appear to present any appreciable change and seem the same as in natural light. If there are several phosphorescence-spectra corresponding to the principal directions of the elasticity of crystals, as it is probable, it has not been possible to separate them, because the vibrations emitted by phosphorescence are not capable of polarisation.

The facts expounded in this note give the explanation of the following phenomenon:—

When a body absorbs or emits vibrations which seem as if they ought to be harmonic, these are affected by a perturbation which tends to approximate the absorption or emission bands in proportion as they are more refrangible. In fact for the same body, the index of refraction varying regularly by the fact of dispersion, each band must be displaced from the theoretical position which it should occupy and be removed so much the more towards the red as the index of refraction is greater. The successive bands must then tend to draw more closely together from the most refrangible side as observation shows. It is possible that a cause of the same order intervenes to determine the successive positions of the emission-rays of incandescent vapours.—*Comptes Rendus* (vol. cii., p. 106.)

CONTROL ANALYSES AND LIMITS OF RECOVERY IN CHEMICAL SEPARATIONS.*

By ALBERT B. PRESCOTT.

EVERY day chemical determinations are made by methods the shortages of which are unknown. Results are checked against other results in parallel operations; processes are compared with other processes as to highest obtainable results; the operator does the best he can, but has no factor of correction for inevitable deficiency. Certain operations in constant demand, in the service of industry and in pure science, such as the estimation of phosphorus in irons and the estimation of morphine in opiums, are rated by comparing results with each other, rather than measured by any standard of real truth. In many of these operations full control analyses are difficult to devise. In general, it may be said, trustworthy control operations are possible just to the extent that the material under analysis is capable of synthesis by the chemist. It must be his aim to make the artificial material identical with the original material in the following particulars:—

(1.) All the chemical constituents of the one should be present in the other in like proportion. (2.) The constituent to be estimated, as added in known quantity in the artificial material, should have the same physical condition as well as "chemical purity" that it bears in its quantity obtained from the original material. (3.) The constituents to be separated should in each case hold the same relations of adhesion. Adhesion is in general resistance to separations, holding back the "traces" that lie between our results and complete work.

The control analyses reported in this paper are such as have been resorted to at different times to test methods wanted for investigations immediately in hand, and therefore they have not the unity of design that might characterise a series of trials wholly devoted to the measurement of methods.

I. *Recovery of Strychnine from Bread and from Meat.**

Qualitative Limits:—

Limit of strychnine (sulphate) for "good" colour test, from a series of seven graded trials ..	0·0000025 gramme.
1. Recovering from 5 grms. bread, same limit, from a series of six graded trials	0·0001 ,,
Strychnine not recovered from 5 grms. of bread	0·0000975 ,,
Limit of recovery for 1 part of bread	0·0000195 strychnine.
Limit of recovery for 1 part of strychnine..	51282 bread.
2. Recovering from 5 grms. meat, same limit, from a series of seven graded trials	0·00016 gramme.
Strychnine not recovered from 5 grms. of meat	0·0001575 ,,
Limit of recovery for 1 part of meat	0·0000325 strychnine.
Limit of recovery for 1 part of strychnine..	30769 meat.
3. Recovering from 50 grms. meat, same limit, from a series of three graded trials	0·0004 gramme.
Strychnine not recovered from 50 grms. of meat	0·0003975 ,,
Limit of recovery for 1 part of meat	0·00000795 strychnine.
Limit of recovery for 1 part of strychnine..	125786 meat.

The strychnine was taken in solutions of known strength of the sulphate; the mixture with bread and meat was made by twenty-four hours' maceration; the separation was accomplished by a uniform method including treatment with alcohol, repeated on the residue, followed by repeated washing of the acidulated water solution with chloroform, and thorough washing of the same solution, after making it alkaline, with portions of the chloroform. The qualitative test was applied to the dry residue by a drop of sulphuric acid and a just visible fragment of dichromate.

The twenty-four hours' maceration is designed to effect a degree of adhesion, only approaching that usual in the material under analysis for poison. In comparing the results of group 2 with those of group 3 of tests, it is remarkable that by working with quantities ten times larger the ratio of recovery is made four times better. This indicates too great a degree of waste resulting from the manipulation, and implies that, especially in small operations, greater care should be taken in execution of every detail.

* Read at the Ann Arbor meeting of the American Association for the Advancement of Science, August 27th, 1885.

* These experiments make a part of an investigation, including trials of recovery from portions of the body after administration to animals, made by G. A. Kirchmaier, under the advice of the writer, and communicated in *Contributions from the Chemical Laboratory of the Univ. of Mich.*, ii., Ann Arbor, 1885.

II. *Recovery of Morphine from Bread and from Animal Tissues.*

Qualitative Limits* :—

Limit of morphine (sulphate) for good colour test	0·00005 gramme.
1. Recovery from 64 grms. bread, same limit, from a series of four graded trials	0·0004 ,,
Morphine not recovered from 64 grms. of bread	0·00035 ,,
Limit of recovery for 1 part of bread	0·0000054 morphine.
Limit of recovery for 1 part of morphine	185185 bread.
2. Recovery from 64 grms. membranous tissue, same limit, series of four trials..	0·0005 gramme.
Morphine not recovered from 64 grms. of tissues	0·00045 ,,
Limit of recovery for 1 part of tissues	0·000007 morphine.
Limit of recovery for 1 part of morphine	142857 tissues.
3. Recovery from 64 grms. liver same limit, from a series of four trials	0·0005 gramme.
Limits as in 2.	

Quantitative Limits :—

4. Recovery from 128 grms. tissue (membranous) by Meyer's solution, (1), 0·1 grm.	loses 0·01
(2), 0·05 grm.	,, 0·003
With 128 grms. of tissue, average loss of morphine	0·0065
Average loss of morphine for 1 part of tissue	0·000051
Average quantity of tissue for loss of 1 of morphine	19608
5. Recovery from 128 grms. liver, by Meyer's solution,—	
(1), 0·1 grm. ..	loses 0·0036
(2), 0·05 grm...	,, 0·02
With 128 grms. of liver, average loss of morphine	0·0118
Average loss of morphine for 1 part liver	0·000092
Average quantity liver for loss of 1 of morphine	10870

The morphine was taken in solution of the sulphate, o known strength; the mixture of morphine with bread, and with tissues, was made in the finely divided material, without digesting any time; and the separation was done by a constant method, as follows:—The material was extracted with alcohol acidulated with sulphuric acid; the filtrate was neutralised and evaporated to a syrup, then diluted with acidulated water and filtered and washed; the filtrate was concentrated and then washed with amyl alcohol. The remaining washed (aqueous) solution was made slightly alkaline by adding ammonia, and extracted with amyl alcohol, by shaking out with repeated portions. The amyl alcohol solution was washed with a little water and evaporated to dryness. For qualitative test the residue was moistened with sulphuric acid, and then drawn across with a sharp glass rod wet with nitric acid of sp. gr. 1·42. In the quantitative work the residue was taken up in water acidulated with sulphuric acid, and the solution titrated with Meyer's solution of potassium mercuric iodide.

The large waste of morphine in recovery shown by quantitative estimation accords with frequent experience of the instability of the alkaloid, and with the unsatisfactory results of estimations by Meyer's volumetric solution. On the other hand, the very small waste in the recovery shown by the qualitative results is at first surprising. Though the qualitative test itself was found to require twenty times as much alkaloid as sufficed for identification of strychnine, still it appeared that, in an operation only one-third larger, the recovery of morphine was made even more (one-seventh more) nearly complete than the recovery of strychnine. Had the morphine solution been macerated with the tissues twenty-four hours, as was done with the strychnine, the results might have compared very differently. But it is quite in accord with the results here quoted that morphine, though elusive from its instability, may interpose to separations less resistance of adhesion than does the more stable alkaloid strychnine.

III. *Recovery of Arsenic from Liver.**

Quantitative Limits. In comparison of three modes of separation :—

1. By corrosion with chlorate and hydrochloric acid, then precipitating as a sulphide.

	Per cent of liver.
(1.) In 62 gm. liver, 0·00127 As_2O_3 loses	0·00054—0·00087
(2.) ,, 0·00127 ,,	0·00059—0·00095
(3.) ,, 0·00127 ,,	0·00054—0·00085

For 1 part liver, average loss of As_2O_3—0·0000089.
Parts of liver, average for loss of 1 part As_2O_3—112360.

2. By distillation as arsenious chloride.

	Per cent of liver.
(1.) In 62 gm. liver, 0·00127 As_2O_3 loses	0·00056—0·00090
(2.) ,, 0·00127 ,,	0·00057—0·00092
(3.) ,, 0·00127 ,,	0·00059—0·00095

For 1 part liver, average loss of As_2O_3—0·0000092.
Parts of liver, average for loss of 1 part As_2O_3—108695.

3. By corrosion with sulphuric and nitric acids, not precipitating as sulphide.

	Per cent of liver.
(1.) In 62 gm. liver, 0·00127 As_2O_3 loses	0·00032—0·00052
(2.) ,, 0·00127 ,,	0·00034—0·00055
(3.) ,, 0·00127 ,,	0·00033—0·00053

For 1 part liver, average loss of As_2O_3—0·0000053.
Parts of liver, average for loss of 1 part As_2O_3—188698.

The arsenic was taken in a hydrochloric acid solution of arsenious acid, of known strength. After separation the arsenic was in each case estimated by weight of the "mirror" of elemental arsenic, reduced from arsine.

The separation of arsenic is, by either of these methods, entirely satisfactory. It appears that the precipitation as sulphide involves a loss, though very slight, that reduces the efficiency of the older method wherein this precipitation is employed. The qualitative limit of identification is nearly the same for arsenic that it is for strychnine, but the quantitative determination is very close for arsenic and not at all close for strychnine.

(To be continued).

* These experiments were made under the author's direction, by S. G. Steiner, and were in preparation for experiments made in recovering morphine administered to animals.

* These experiments were made, under the author's observation, by Mr. H. J. Holthoefer, in 1883, with the purpose of comparing the efficiency of three rival methods of separation, and the results were published in *Contributions from the Chemical Laboratory of the Univ of Mich.*, ii., p. 87.

ANALYSES OF SOME IRON ORES.

By J. CUTHBERT WELCH.

(Concluded from page 67).

III. *Göthite.*

Formula = $Fe_2O_3.H_2O$.

This requires—

Fe_2O_3	89·89
H_2O	10·11
	100·00

1. From St. Gotthard, Switzerland. Colour blackish brown. Streak dark brownish yellow. Adamantine lustre. Very brittle, but hard. Its specific gravity = 4·223. Metallic iron = 60·299 per cent.

Data.

Iron—
0·5 grm. required 30·15 c.c. potassium bichromate.
Combined water—
5 grms. gave 0·5923 grm. combined water.
Alumina—
5 grms. gave 0·0163 grm. alumina.
Silica—
5 grms. gave 0·0260 grm. silica.
Copper—
1·372 grms. gave 0·0098 grm. copper subsulphide.
Lime—
5 grms. gave 0·0255 grm. calcium sulphate.
Phosphorus—
4 grms. gave 0·0020 grm. magnesium pyrophosphate.

Percentage.

Fe_2O_3	86·142
H_2O (combined) ..	11·846
Al_2O_3..	0·326
SiO_2	0·520
CuO	0·714
CaO	0·210
P_2O_5	0·032
	99·790

This gives—

Fe_2O_3	87·911
H_2O	12·089
	100·000

2. A reddish brown specimen from Tincroft, Cornwall. It was partially encrusted by small tourmaline crystals, of a fine black colour, the largest being ¼ inch in length. Reniform. Streak yellowish brown. Not very hard, although fairly compact. Two determinations of its specific gravity gave 4·302 and 4·365; mean = 4·324. Metallic iron = 60·320 per cent.

Data.

Iron—
0·25 grm. required 15·08 c.c. potassium bichromate.
Combined water—
5 grms. gave 0·5707 grm. combined water.
Alumina—
5 grms. gave 0·0380 grm. alumina.
Silica—
5 grms. gave 0·0408 grm. silica.
Lime—
5 grms. gave 0·0087 grm. calcium sulphate.
Magnesia—
5 grms. gave 0·0022 grm. magnesium pyrophosphate.
Manganese—
2 grms. gave 0·0073 grm. trimanganic tetroxide.
Arsenic—
4 grms. gave 0·0172 grm. magnesium pyroarsenate.

Percentage.

Fe_2O_3	86·172
H_2O (combined) ..	11·414
Al_2O_3..	0·760
SiO_2	0·816
MgO	0·016
CaO	0·072
MnO	0·339
As	0·208
	99·865

This gives—

Fe_2O_3	88·304
H_2O	11·696
	100·000

The preceding analyses were all made upon a sample as free from gangue as possible, in order to obtain a good notion of the composition of the ores themselves. The results obtained prove, in my opinion, that those substances present foreign to the chemically pure ore are actually in combination in the ore itself, and that their presence is not due to admixed portions of the gangue.

The potassium bichromate solution used was such that 1 c.c. = 0·01 Fe.

The analyses of all the specimens were made upon the original hygroscopic ore, and the results given under the column headed "Dried at 100° C." are calculated from these percentages previously obtained, the hygroscopic water having been determined at this temperature.

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.*

By P. T. CLEVE.

(Continued from p. 69).

Selenates of Samarium.

I. $Sm_2(SeO_4)_3 + 8H_2O$. This salt crystallises from a very concentrated solution on evaporating over oil of vitriol at 18°, in small sulphur-yellow crystals. The selenate is very soluble; it loses scarcely any water at 100°, but it becomes anhydrous at 280°.

1. 0·9881 grm. lost on careful heating over open fire 0·1642 grm., and left on heating to a white heat 0·3951 grm. Sm_2O_3.

2. *a.* 0·6223 grm. decomposed with boiling hydrochloric acid and treated with sulphurous acid gave 0·1679 grm. Se. From the filtrate 0·2457 grm. Sm_2O_3 was thrown down with oxalic acid.

b. 0·8165 grm. lost by 280° 0·1330 grm. H_2O.

In per cent—

	I.	II.	Calculated.	
Sm_2O_3	39·99	39·48	348	39·86
SeO_3	—	43·37	381	43·64
H_2O	16·62	16·29	144	16·50
			873	100·00

The selenate of samarium does not give any compound with selenate of sodium. On spontaneous evaporation of the mixed solutions one gets crystals of selenate of samarium.

Sp. gr. of the crystallised salt—
1·3973 grm. crushed crystals, t° 13°, sp. gr. 3·326
1·2697 „ „ „ „ 3·329
Mean of both determinations, 3·327.
Molecular volume, 262·4.

II. $Sm_2(SeO_4)_3 + 12H_2O$. It crystallises at about 10° in yellow brilliant beautiful prisms which alter rapidly in the air.

0·4915 grm. lost by 100° 0·1204 grm. H_2O and by 230° 0·0850 grm. By ignition 0·3549 grm. Sm_2O_3 was obtained.

1·5643 grm. lost by 230° 0·3425 grm. H_2O.

In per cent—

Sm_2O_3	37·70	348	36·83
SeO_3	(40·47)	381	40·32
H_2O by 100°	12·79	$7H_2O$ 126	13·32
H_2O by 230°	9·04	$5H_2O$ 90	9·53
	100·00	945	100·00

Specific gravity—
1·6569 grm. crystals, t° 10°, sp. gr. 3·009
1·6110 „ „ „ „ 3·010
Molecular volume, 314.

* Presented to the Royal Society of Sciences of Upsala, Feb. 13, 1885.

III. $Sm_2(SeO_4)_3$ anhydrous salt was obtained by heating the crystallised salt II. to 230°.

Specific gravity—

1·2165 grm., temp. 10°, sp. gr. 4·077

Molecular volume, 178·8.

Selenate of Samarium and Potassium.

$SmK_2(SeO_4)_2 + 3H_2O$.

This double salt crystallises from the mixed solutions of the simple salts by spontaneous evaporation at a summer heat in small topaz-yellow needles attached to semi-spherical masses. The salt is easily soluble in water.

0·6512 grm. lost scarcely anything at 100°, but 0·0666 grm. H_2O at 220°. It gave 0·1946 grm. Se, 0·2123 grm. Sm_2O_3, and 0·1066 grm. H_2SO_4.

2·9465 grm. lost by 230° 0·3037 grm. H_2O.

In per cent—

			Calculated.	
Sm_2O_3	32·60	—	348·0	32·89
SeO_3	48·04	—	508·0	48·01
K_2O	8·85	—	94·2	8·90
H_2O	10·23	10·37	108·0	10·20
	99·72		1058·2	100·00

Specific gravity of the crystallised salt—

1·4475 grm. crystals, t° 18°, sp. gr. 3·541

1·4284 „ „ 10° „ 3·566

Mean of both determinations, 3·553.

Molecular volume, 148·9.

Specific gravity of the anhydrous salt—

1·3838 grm, t° 10°, sp. gr. 4·129

1·2551 „ „ „ 4·098

Mean of both determinations, 4·113

Molecular volume, 115·5.

Selenate of Samarium and Ammonium.

$SmNH_4(SeO_4)_2 + 3H_2O$.

By spontaneous evaporation of the mixed solutions of selenate of samarium and of ammonium, the latter in excess, small topaz-yellow tablets grouped together into hemispherical masses are obtained.

I. *a.* 1·0704 grm. lost by 210° 0·1132 grm. H_2O and gave 0·3298 grm. Se and 0·3644 grm. Sm_2O_3;

b. 3·0306 grm. lost by 210° 0·3248 grm. H_2O.

c. 0·8643 grm. gave 0·2670 grm. Se and 0·2952 grm. Sm_2O_3.

II. 0·4796 grm. lost by 220° 0·0521 grm. H_2O and gave 0·1479 grm. Se and 0·162 grm. Sm_2O_3.

In per cent—

	I. *a.*	*b.*	*c.*	II.	Calculated.	
Sm_2O_3 ..	34·04	—	34·15	33·78	348	34·25
SeO_3 ..	49·53	—	49·66	49·58	508	50·00
$(NH_4)_2O$..	(5·85)	—	—	(5·78)	52	5·12
H_2O.. ..	10·58	10·72	—	10·86	108	10·63
					1016	100·00

Specific gravity of the crystallised salt—

I. 1·1411 grm. crystals, t° 14°, sp. gr. 3·277

1·6452 „ „ „ 15° „ 3·263

II. 0·7559 „ „ „ 18·6° „ 3·260

Mean of the three determinations, 3·266.

Molecular volume, 155·9.

Sp. gr. of the anhydrous salt—

1·0997 grm., t° 14°, sp. gr. 3·805.

Molecular volume, 119·3.

Sulphite of Samarium, $Sm_2(SO_3)_3 + 3H_2O$.

The oxide of samarium dissolves easily in a saturated aqueous solution of sulphurous acid. If the clear solution be heated on a water-bath a white amorphous powder is thrown down. For analysis the salt was pressed between filter-paper.

0·4105 grm. lost by 100 to 110° 0·0159 grm. H_2O and gave 0·4024 grm. $Sm_2(SO_4)_3$.

0·4110 grm. lost 0·0142 grm. and gave 0·4047 grm. $Sm_2(SO_4)_3$.

In per cent—

			Calculated.	
Sm_2O_3	58·02	58·28	348	58·59
SO_2	—	—	192	—
H_2O	3·87	3·46	54	9·03
			594	

The salt loses at 100° $1H_2O$.

Selenites of Samarium.

1. *Basic Salt.*—On adding an excess of neutral selenite of sodium to the sulphate of samarium a voluminous and gelatinous precipitate is thrown down. This precipitate was dried at 100° and analysed.

0·9005 grm. dissolved in HCl and precipitated with SO_2 gave 0·2735 grm. Se. The Sm_2O_3 obtained from the filtrate by precipitation as oxalate amounted to 0·462 grm.

In per cent—

Sm_2O_3	51·30
SeO_2	42·67
H_2O	(6·03)
	100·00

The ratio between Sm_2O_3, SeO_2, and H_2O is 1 : 2·6 : 2·3 or 3 : 8 : 7.

The precipitate consisted of a basic salt the composition of which, if it be regarded as a chemical compound, may be expressed by the formula—

$3Sm_2O_3,8SeO_2 + 7H_2O$.

Sm_2O_3	1044	50·73
SeO_2	888	43·15
H_2O	126	6·12
	2058	100·00

It seems most probable that it is only a mixture o basic salts with the neutral selenite. According to M Nilson the selenite of didymium, prepared in the same way as this salt, has the composition—

$3Di_2O_3,8SeO+28H_2O$.

2. *Acid Selenite*, $Sm_2O_3,4SeO_2 + 5H_2O$.— This compound was thrown down by addition of selenious acid to the solution of the acetate, as a bulky precipitate, which was very soon transformed into microscopic needles.

0·8312 grm. lost at 110° 0·0523 grm. H_2O, and gave, treated in the same manner as the salt last described, 0·2935 grm. Se and 0·3233 grm. Sm_2O_3.

0·8910 grm. gave 0·0560 grm. H_2O, 0·3175 grm. Se and 0·3465 grm. Sm_2O_3.

In per cent—

			Calculated.	
Sm_2O_3	38·90	38·89	348	39·46
SeO_2	49·61	50·07	444	50·34
H_2O..	6·29	6·28	$3H_2O$ 54	6·12
			$2H_2O$ 36	—

Carbonate of Samarium,

$Sm_2(CO_3)_3 + 3H_2O$ (or $2H_2O$ dried at 100°).

The gelatinous precipitate which the nitrate of samarium gives with ammonia liquor was, after washing with cold water, suspended in water and treated with carbonic acid gas. After some time a whitish powder consisting of aggregates of microscopic needles insoluble in water was obtained. The salt pressed between filter-paper lost at 100° 4·70 per cent (1 mol. H_2O = 3·37 per cent).

0·401 grm. dried at 100° gave by ignition 0·2673 grm. Sm_2O_3.

0·2852 grm. was mixed with bichromate of potash and heated in a combustion-tube. The water was accidentally lost, but the carbonic acid, absorbed by potash ley, weighed 0·0738 grm.

0·3269 grm. gave 0·2186 grm. Sm_2O_3.

In per cent—

			Calculated.	
Sm_2O_3	66·66	—	66·87	348	67·44
CO_2	—	25·88	—	132	25·58
H_2O	—	—	—	36	—
				516	

Carbonate of Samarium and Potassium,
$SmK2CO_2 + 6H_2O$.

A solution of the nitrate of samarium gives, on adding bicarbonate of potassium, a voluminous gelatinous precipitate, which, in presence of an excess of the bicarbonate, is after a time changed into thin glittering crystals. The salt, after pressing between filter-paper, was analysed :—

I. 0·7635 grm. lost by 100° 0·1742 grm. H_2O. The residue was dissolved in hydrochloric acid and precipitated with ammonia. The solution of the hydrate, thus thrown down, was precipitated with oxalic acid and the oxalate ignited. The filtrate from the hydrate was evaporated, the residue carefully ignited and weighed as KCl. 0·3204 grm. Sm_2O_3 and 0·132 grm. KCl were thus obtained.

II. 0·4701 grm. lost at 125° 0·1146 grm. H_2O and gave 0·1964 grm. Sm_2O_3 and 0·0844 grm. KCl.

In per cent—

	I.	II.	Calculated.	
Sm_2O_3	41·96	41·78	348·0	41·72
K_2O	10·92	11·34	94·2	11·29
CO_2	—	—	176·0	—
H_2O	22·82	24·38	216·0	25·89
			834·2	

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 4th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Messrs. Robert G. Cristopher, George E. R. Ellis, and E. E. H. Thorne were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. James Henry Allan, 6, St. Chrysostom Street, Liverpool ; Leopold Mandeville Deane, 52, Elswick Road, Newcastle-on-Tyne ; Preo Loll Day, 4, Bradon Street, Calcutta ; James Arthur Formoy, 12, Railway Approach, London Bridge ; Edward Willmore, 69, Lichfield Road, Bow, London, E.

The following note was read :—

12. "*The Chemical Formula for Wool Keratine.*" By Edmund J. Mills, D.Sc., F.R.S.

In the last number of the *Proceedings* Mr. Whitely points out, in Abstract No. 10, that Mills and Takamine gave (*Chem. Soc. Trans.*, 1883, 142) a necessarily wrong formula for wool, their calculation having been based on data in Gmelin's *Handbook*, xviii., 351, where H is misprinted for N. Mr. Whitely then deduces from the corrected results the formula $C_{41}H_{71}N_{12}SO_{14}$.

I wish to point out in the first place that, in the paper by myself and Takamine, the formula of wool was merely an incident, the main object being to give an account of the absorption of weak reagents, by cotton, silk, and wool. In the second place, I myself noticed the misprint in Gmelin's *Handbook* as long ago as last May (*Journ. Soc. Chem. Ind.*, 1885, 328), and calculated out for wool the corrected formula $C_{39}H_{65}N_{11}SO_{13}$, which agrees well with the results of its destructive distillation.

A Lecture was delivered on—

13. "*Methods of Bacteriological Research from a Biologist's Point of View.*" By Dr. Klein, F.R.S.

The object of the Lecture was to bring before the Chemical Society the methods used at present by pathologists in the investigations of micro-organisms associated with disease. These methods, thanks to the investigations of Koch, are greatly in advance of those hitherto employed by chemists in the investigation of the activity of bacteria. The enormous amount of work that has been done by chemists since the memorable investigations of Pasteur on fermentation and putrefaction, if viewed in the light of the modern bacteriological methods) is in a great measure unsatisfactory and imperfect, more so than will be conceded by chemists. This unsatisfactory state is chiefly due to the imperfect methods employed. Specific chemical action is ascribed to certain organisms, because these were found present in the substances examined, no regard being paid as to whether these organisms were alone active or whether they were only concomitant and dependent on the activity of others.

Numbers of instances can be adduced to prove this : amongst them may be mentioned the assertions that alcoholic fermentation is produced by *Mucor racemosus*, and also by a bacillus besides saccharomyces ; that the ammoniacal fermentation of urine is due to a bacillus ; that the lactic acid fermentation is due to a micrococcus and also to a bacillus.

To determine whether a definite chemical process is produced by a definite organism, and which, it is necessary to prove—(1) that the substances to be acted upon are at the outset free of any accidental organisms ; (2) that the particular organism to which the definite chemical activity is ascribed is the only one concerned in this process.

The methods used must fulfil these elementary conditions, that is to say :—(1) the materials used must be sterile at the outset, and protected from accidental contamination ; (2) the specific organism must be obtained in pure cultivations, and this purified organism must be capable of producing the specific chemical change.

Viewed in this light few of the assertions hitherto made bear criticism. As one of the most striking instances it may be mentioned that, notwithstanding the enormous amount of knowledge gained by chemical research into the changes of proteid bodies during putrefaction, there is no reliable answer yet given to the questions—Which organism or organisms are concerned in this complex process ? Which part of the process is due to which organism ? Is the analytical process by which proteids are carried down to relatively simple nitrogenous principles done by one or more organisms and by which ? Is the production of the alkaloids known as ptomaines due to the same organism or organisms which started the process of putrefaction ?

Another equally important series of investigations refers to the process of nitrification ; here also no definite answer can be given. So also the chemical changes due to the growth of moulds are waiting for investigation.

When chemical research begins to adopt such methods as are employed by pathologists, but not till then, its results will be unequivocal.

The methods used for sterilising materials, for studying and recognising the morphological characters of organisms, for obtaining pure cultivations, and for inoculating nutritive materials with them were then minutely described.

Discussion.

Prof. Frankland, after dwelling on the importance of intercourse between biologists and chemists, said that he

must plead guilty to the charge of having neglected precautions now known to be necessary when making his experiments on the fermentation of urine; he could, however, urge that there were extenuating circumstances, as the experiments were carried out ten years ago when the necessity of such precautions being taken was not yet realised. He did not contend that the vibrios observed by him were the sole agents, but they were for days apparently almost exclusively present. It appeared to him that a point of primary importance brought forward by Dr. Klein was the fact that certain pathogenic organisms only develop at a relatively high temperature. It was probable that in the future the study of the chemical effects of organisms would be of greater service even than that of morphological characters as a means of differentiating various organisms. As regards *Mucor racemosus*, the statements in his paper were derived from the published researches of Dr. James Bell.

Mr. Warington described the conditions under which his experiments on nitrification were made. The solutions contained a very small proportion of nutritive matter, and the action was extremely slow: after three or four days a slight turbidity was observed, but nitrification did not set in until after about one month. He had made four or five successive cultivations, more being impossible by reason of the slowness of the action.

Dr. Percy Frankland said that, as Dr. Klein had properly stated, he had not asserted that the number of organisms found present on his plates was the number of organisms present in the water examined. His experiments were made not so much with the object of discovering pathogenic organisms, but in order to study what took place in the ordinary processes of water purification. Of all known media he thought that none was so universally applicable to the cultivation of micro-organisms as gelatin peptone. The danger from air contamination was perhaps overrated. To illustrate how very slight is the contamination, he had recently exhibited a series of 12 plates put up with sterilised water, and of these only one had a growth upon it. He had recently made experiments with air confirming Hesse's observations, having found only 10 organisms in 20 litres—this, however, being in snowy weather. He had also made experiments on the number of organisms which fell upon a plate of gelatin such as was employed when working according to Koch's directions, and had found about two per minute. He thought that the experiments on fermentative action hitherto made were worthless from neglect of the precaution to employ pure cultivations.

Dr. Armstrong said that it undoubtedly was most important that the necessity of using pure cultivations should be impressed upon the chemist, but the work hitherto done in this field, far from being worthless as Dr. Percy Frankland had stated, was absolutely of almost as great value as if pure organisms had been dealt with. In most cases of putrefactive change the products were very numerous, their separation and identification was excessively difficult, and in not a few instances they were new to the chemist. Until the chemical methods of examining such products had been perfected, it was useless to incur the great labour involved in obtaining pure cultivations on a sufficient scale. This had been clearly recognised by most of the recent workers on the subject.

Mr. Ekin inquired if the organisms present in water might not play the part of useful scavengers? Evidence of this would, he believed, ere long be forthcoming.

Dr. Thudichum observed that the biologist working with impure ferments could be compared to the chemist employing impure reagents. The results of the life of microzymes were to a large extent chemical, as was known from ordinary fermentation; this was equally true of ferments which caused diseases. Thus in splenic fever, which he had investigated on a farm in Leicestershire, where it was endemic, he had found all hæmochrom transformed into methæmoglobin, and the spleen filled with crystals of albuminous decomposition products. In cholera a poison was formed by the bacilli which affected the muscles, and by fluidifying the colloids caused sinking of temperature, or the algid stage. In all diseases, however, the presence of bacilli, as in all fermentations, led to the evolution of heat, which with its attendant symptoms was termed fever. Fever heat had two sources; one was increased combustion, another the liberation of latent or atomic heat which was peculiar to the bioplasm. Now this liberation of atomic heat under the influence of the bacilli or their products led to a remarkable consequence, namely, a contraction of the atomic volume of the bioplasm; and when the tissues had attained the smallest atomic volume compatible with their function, bacilli could no longer live or thrive in them; the contracted bioplasm had attained to the state of immunity from the bacilli and their products. This state of immunity was attained not only through the action of specific bacilli, but also of their modification called vaccines. He agreed with Dr. Armstrong in two particulars concerning the chemical treatment of questions connected with bacilli. The fermentations might be studied with impure ferments, provided the processes were on a large scale, and a recognisable particular ferment prevailed. All possible decomposition products might be investigated first, and then the results of fermentations with pure ferments, or pure cultivations of bacilli, would be much easier of discovery. In particular, as a pathologist, he was quite certain that investigations of a chemical kind on the changes effected by microzymes in the composition of animal tissues and fluids would not be adequately successful before the entire chemistry of these substances and all their decomposition products was completely known.

The President asked Dr. Klein whether the statement had been confirmed that *B. amylobacter* loses its specific character by cultivation in oxygenated media and when its spores are heated.

Dr. Klein, in reply, said that he agreed with Prof. Frankland that the chemical aspect of the problem was the important one to study in the future: at present it was entirely unknown how the diseases associated with the presence of anthrax or the tubical bacillus, for example, were produced. Light had in most cases a deleterious influence on the growth of bacteria; but some live only in light, and it had been stated that the so-called *Bacterium photometricum* lived only when exposed to a definite part of the spectrum. Dr. Percy Frankland had somewhat misunderstood him: he certainly thought that the gelatin method was the most useful one to employ in determining the number of bacteria in two given specimens of water, but he did not agree that gelatin-peptone was the most universally applicable medium; several organisms would grow in agar-agar, but not in gelatin, and blood serum was certainly better—indeed he did not know any organism which would not grow in it. As regards the struggle between organisms, there were cases known of non-pathogenic causing the destruction of pathogenic organisms present along with them. With reference to the employment of pure cultivations, what he had desired to point out was that the statments that certain chemical changes were brought about by certain organisms were based upon insufficient evidence—he wanted to have them placed beyond question by the use of pure cultivations. Changes such as were referred to by the President certainly took place; thus Pasteur had found it possible to alter the functions of the *Anthrax bacillus*.

At the next meeting on February 18, there will be a Ballot for the Election of Fellows, and the following papers will be read:—

"On the Constitution of Undecylenic Acid as indicated by its Magnetic Rotation; and on the Magnetic Rotation, &c., of Allylacetic Acids and Ethylic Diallylmalon." By W. H. Perkin, F.R.S.

"On Reactions supposed to yield Nitrosyl Chloride." By W. Collingwood Williams, B.Sc.

"On the Condition in which Silicon exists in Cast Iron." By A. E. Jordan and T. Turner.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, February 1, 1886.

WARREN DE LA RUE, M.A., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

THE following were elected Members:—William Anderson, M. Inst. C.E., Henry Arthur Blyth, James Blyth, James Crowdy, Brownlow D. Knox, Mrs. Shepherd, W. F. R. Weldon, M.A.

Sixteen Candidates for Membership were proposed for election.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

A Practical Introduction to Chemistry: intended to give a Practical Acquaintance with the Elementary Facts and Principles of Chemistry. By W. A. SHENSTONE, Lecturer on Chemistry in Clifton College. London: Rivingtons.

WE have from time to time had occasion to express our regret at the multiplication of chemical annuals not evincing any special *raison d'être*. The little work before us has, however, a very definite aim, and a method which appears to us thoroughly scientific. The very first sentence in the author's Introduction is so significant that, were we a Sultan of the "Arabian Nights," we would have it written up in letters of gold over the door of every college and school in our realm:—"There can be no doubt," he writes, "that Science is of special educational value chiefly in proportion as it leads the students to observe accurately, to record their observations correctly, and to think for themselves." That a teacher who carries out this view will train up his pupils to *know* cannot be questioned. Whether they will *pass* better than, or as well as, others taught in a less rational manner is another affair. The arts of accurate observation and of drawing correct conclusions from observations made and recorded do not seem capable of being estimated by examiners.

Mr. Shenstone does not begin operations with giving a brief account of the elements *seriatim*, to be received as a creed and committed to memory. His first chapter deals with "Burning." But he writes—"In this book you will not be told straight off what is known on this and other subjects. Instead of that you will be instructed to make certain experiments, and you must try and find out for yourself what the experiments teach you about the subjects. If you do this earnestly you will gradually gain the power of making discoveries for yourself, which is much better than being told things." Most true: this is the only way in which chemistry, or indeed any science, can be rationally taught,—the only method by which discoverers and inventors can be trained up. Why do we, as a nation, so obstinately reject it?

We feel convinced that the Clifton College will give practical proof of the soundness of the author's views if the "tyrant Examinationalism" do not interfere.

Chemical Student's Manual for the Lecture-Room and Laboratory: embracing Non-metals, the Analysis of Simple Salts, Historical and much other Useful Memoranda. By H. L. BUCKERIDGE, F.C.S., A.A. (Oxon), &c. London: Murby.

THE author tells us that his aim—modest, though not the less difficult—is to present the student with a book of notes, comprehensive, systematic, of easy reference, and therefore "of the utmost possible service in the laboratory, the lecture-room, or in the seclusion of private study." The Preface ends with the *banal* announcement that the course laid down is such as to prepare the student for—&c., &c.

The "Chemical Notabilia" consist of elementary definitions, statements of certain laws, remarks on notation, instances of different kinds of formulæ, tables of weights and measures, the determination of vapour-densities, dates of discoveries, typical problems, a glossary, and a string of questions. The glossary gives the explanation of only some twenty terms, some of them, such as "inflammable" and "malleable," of such common use as to be universally understood.

It might be difficult to find in this volume anything to which we might fairly object; but it would be also difficult to find any marked advantage which it possesses as compared with other elementary chemical treatises.

Chemiker-Kalendar, 1886. *Ein Hülfsbuch fur Chemiker, Physiker, Mineralogen, Industrielle, Pharmaceuten, Hüttenmänner, u.s.w.* (Chemist's Amanac, 1886. An Aid-Book for Chemists, Physicists, Mineralogists, Manufacturers, Pharmacists, Metallurgists, &c.) By Dr. RUDOLF BIEDERMANN. Seventh Year, 1886. Berlin: J. Springer.

THIS calender continues its career of usefulness. In the preliminary almanac department we find given the meetings of the principal scientific and technological societies of Berlin, followed by a brief table of frequently required atomic weights and their multiples. Amongst the principal additions in the issue for the current year particular attention must be called to the chapter on thermochemistry, with the tables on formation-heats. In the chapter on light new tables of wave-lengths and on the exponents of refraction have been added. The section on electricity has been enlarged in view of the increasing development of electrolytic analysis and of metallurgy. There are also tables of elasticity and hardness, which of course concern the chemist much less than the engineer. Most of this additional matter is contained in an appendix printed as a small separate volume. An interesting feature is a list of dates of remarkable discoveries and inventions, not confined exclusively to chemistry, and of other important events in the history of science. Here we must point out an error. We read "Foundation of the Royal Academy in London, 1662." It should be "Royal Society," the Royal Academy being a totally different body of much later origin, and not being concerned with scientific research, but with the fine arts. It may call up a smile or a sigh, according to the reader's point of view, to find the first establishment of the betose manufacture placed among the world's memorable events! In the diary department we find the anniversaries of the birth- and death-days of the eminent scientific men of all nations. By a clerical or typographic error we find the birth-place of Isaac Newton given as "Whoolstorpe." In spite of the great condensation necessary in compressing such a wonderful amount of useful matter into a strictly pocket-size there is no fear of injury to the eyes. The paper is of excellent quality, and the type, though necessarily small, is beautifully clear. The arrangement of the subject matter is also such that no space is wasted. The "Chemiker-Kalendar" may indeed be pronounced a model in its kind.

Chlorination of Carbides.—A. Colson and H. Gautier.—Phosphorus perchloride is a reagent which renders it possible to introduce a given quantity of chlorine into the hydrocarbon molecule. The chlorine liberated by the decomposition of the perchloride reacts at first upon the lateral chains before attacking the benzol nucleus.—*Bull. de la Soc. Chim. de Paris*, No. 1, 1886.

CORRESPONDENCE.

OXIDE OF IRON AND ALUMINA IN PHOSPHATES.

To the Editor of the Chemical News.

SIR,—By the publication of the method used by himself, (CHEM. NEWS, vol. liii., p. 51) Mr. Bernard Dyer has done much to secure the adoption of a uniform method for the estimation of iron and alumina in commercial phosphates.

If he and his brother analysts could be induced to publish their methods of estimating phosphoric acid in phosphates and manures, they would confer a boon upon manufacturers, works' chemists, and every one concerned.

There can be no doubt that the discrepancies complained of in oxide of iron and alumina determinations are in part caused by the use of different solvents. Hydrochloric acid, nitric acid, and *aqua regia* are indiscriminately used to effect solution of the phosphates, the iron and alumina found in solution being returned as "oxide of iron and alumina."

Such results are clearly misleading, and are of no practical value to the manufacturer, as the amount of iron and alumina present in a phosphate over and above that which is soluble in sulphuric acid is a matter of indifference to him.

Instead of seeking to show the amount of iron existing as oxide, phosphate, pyrites, ferrous silicate, &c., it would be much simpler to estimate the amount of iron and alumina which is soluble in the solvent actually employed in the manufacturing process, the result being stated as oxide of iron and alumina soluble in sulphuric acid. The results obtained in this way would have at least a practical value, which many of the present determinations do not possess.

The following table shows the results which I have obtained by dissolving the phosphates in sulphuric acid as suggested above, and also, for comparison, those obtained by dissolving in hydrochloric acid to which a little nitric acid has been added, the iron and alumina being precipitated and weighed as phosphates.

Name of phosphate.	Phosphates of iron and alumina in $HCl+HNO_3$ solution.	Phosphates of iron and alumina in H_2SO_4 solution.
1. Bull River	7·30	3·00
2. „	6·05	2·45
3. „	5·10	3·40
4. Port Royal	8·38	2·31
5. „	6·66	2·50
6. „	5·77	1·52
7. Oak Point	7·13	3·53
8. Bolton River ..	7·38	2·82
9. Sand, Carolina ..	10·68	7·15
10. Chisolm Rock ..	7·32	5·50
11. Spanish..	3·75	2·35
12. „	2·66	1·75
13. Canadian	6·75	2·85
14. „	5·75	3·15
15. „	4·47	1·95
16. Belgian..	26·00	20·60
17. „	17·85	14·00
18. „	3·05	1·52
19. „	1·95	1·20
20. Aruba	9·12	5·37

It will be seen from this table that some of the phosphates (Nos. 4 and 8, for instance) which show a comparatively large amount soluble in the *aqua regia* solution contain only a small amount soluble in sulphuric acid.

With regard to the method of estimating the iron and alumina, the following process, which contains nothing original, gives good results:—10 grms. of the sample are boiled with hydrochloric acid and evaporated to dryness with a little nitric acid. The residue is taken up with hydrochloric acid, filtered, and the filtrate made up to 500 c.c.

Three portions of 100 c.c. each are taken for analysis.

In the first the ferric oxide is estimated volumetrically.

The second and third are precipitated with ammonic acetate. The precipitates, after being washed on filters, are dissolved in hydrochloric acid, some sodic phosphate added to the solution, and the ferric and aluminic phosphates again precipitated with ammonic acetate. One of the precipitates is dissolved in nitric acid and the phosphoric acid estimated by means of molybdic acid. The other precipitate is ignited and weighed as total phosphoric acid, ferric oxide, and alumina.

The phosphoric acid and ferric oxide found being deducted from the total, the difference gives the alumina.

When it is desired to estimate the iron and alumina soluble in sulphuric acid it is advisable to dilute the solution largely before boiling to ensure complete decomposition of the phosphate.—I am, &c.,

WILLIAM W. MELLON.

Ouse Chemical Works, Howden, Yorks.
February 3, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiv., Part 10.

The Proportion of Oxygen in Atmospheric Air.—Prof. U. Kreusler.—The author, in view of the recent doubts as to the constant composition of the atmosphere, raised by Von Jolly and others, maintains—as the result of a series of 106 analyses—the correctness of the ordinary assumption of constancy within very narrow limits, so that the conflicting observations are not sufficiently guaranteed.

Magnetic Particles of the Atmosphere.—P. Bonizzi.—The author has examined very closely the magnetic particles of atmospheric dust, collected in the most different localities of Italy. He finds that in all kinds of dust, whether collected in the open air or in closed spaces, there are always present magnetic particles, differing in number and in size. These particles are not homogeneous, but differ in their mineralogical composition. In form they vary greatly, though the globular shape predominates. The dusts collected in exposed localities almost invariably contain spherical magnetic bodies, which are rarer or altogether wanting in the dust of closed localities.

The Pollution of the Emscher at Dortmund.—A. Müller.—The impurities of the Emscher, a small tributary of the Rhine, are traced to the influx of foul waters above Dortmund, the sewage of the town, the waste waters of breweries, and the drainage of the mines. The last-mentioned waters are poor in organic matter, but their high percentage of sulphates in contact with putrescent organic matter gives rise to a plentiful liberation of hydrogen sulphide, and renders them unfit for irrigation. Analyses made at different points of the stream prove that a process of self-purification takes place.

Purification of Impure and Foul Industrial Waste Waters of Irrigation.—J. König and C. Böhmer.—The authors find that treatment with lime still leaves much impurity in the water. Irrigation requires the largest possible surfaces and very permeable soil. They consider also that the mere removal of the suspended impurities is insufficient.

Joint Manurial Experiments in the Province of Hanover.—Prof. Drechsler.—The results of these experiments are given in the form of tables.

Changes in and Preservation of Farmyard Manure.—Dr. E. Heiden.—Superphosphate-gypsum (the composition of which is not stated, but which may be the "phosphatic gypsum" of the English trade) is found to retain ammonia rather better than kainite.

The Gastric Juice and the Histology of the Mucous Membrane of the Stomach of Swine.—Ellenberger and Hofmeister.—The gastric juice of swine contains the same ferments as that of other domestic animals. It dissolves albumenoids, converting them into peptone, propeptone, and syntonine; coagulates milk and splits up the fats, though only to a slight extent.

The Digestibility of Cotton-Seed Cake and Meal.—H. Weiske, B. Schulze, and E. Flechsig.—The nutritive value of cotton-seed cake is given as slightly higher than that of rape cake, with the additional advantage that cattle eat it with more relish.

Experiments on the Influence of the Ingestion of Free Acids upon the Digestive Process in the Herbivora, as well as upon the Metabolism of Nitrogen and Mineral Matters in their Bodies.—H. Weiske and others.—The authors consider that the digestive coefficients of acidified and of normal hay differ little. In animals fed with sulphuric hay, all the bones except the skull and those containing marrow were found about 2 per cent poorer in mineral matter than those of animals fed on normal hay.

The Growth and Increase of Crystals.—O. Kœppert.—The author has made a comparative examination of the size and number of crystals of calcium oxalate in the corresponding parts of young and old plants.

The Influence of "Topping" upon the Development and Productiveness of Plants.—E. Wollny.—Upon sunflowers the influence of topping varies according to the time when it is performed. All topped plants bloomed later than those not topped, and produced imperfect seeds. In the case of tobacco topping promotes the growth of leaves. In peas and beans the quantity both of straw and fruit is diminished. Maize is improved both in quantity and quality. In potatoes both the number and the weight of the tubers were reduced.

A Ferment in Plants which transforms Cellulose into Gum and Mucus.—Julius Wiesner.—The author has observed that gum-arabic contains a ferment which in the plant effects the conversion of cellulose into gum. This gum-ferment is of a diastatic character, but it is distinguished from other diastases by converting starch merely into gum, and not into reductive sugar. It even seems capable of annulling the action of ordinary diastase.

The Blackening of the Roots of Young Beet-Plants.—Prof. Kühn.—Injury is occasioned by the larvæ of *Atomaria linearis* and by certain species of *Julus*.

The Use of Copper Sulphate for Destroying Peronospora viticola.—A. Perrey.—From the *Comptes Rendus*.

On House Fungus.—Poleck.—This fungus, *Merulius lacrimans*, attacks chiefly timber felled in spring and summer. Its ash contains 75 per cent of potassium phosphate.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Tartaric Acid.—As we deal in tartaric "matters" we should be very glad to know the statistics for England, import and export, of tartaric acid, cream of tartar, raw products (wine lees, tartar, &c.), and also, if possible, the consumption in England.—P. and E. Gasquy de B. E & Co., Marseilles.

MEETINGS FOR THE WEEK.

Monday, 15th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Science Teaching," by Prof. F. Guthrie, F.R.S.
Tuesday, 16th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum," by C. T. Newton, C.B.
— Society of Arts, 8. "The Present State of the Colonial Possessions of Great Britain," by Dr. Robert J. Mann.
Wednesday, 17th.—Society of Arts, 8. "Some Points in Electrical Distribution," by Prof. George Forbes.
— Meteorological, 7.
Thursday, 18th.—Royal, 4.30.
— London Institution 7.
— Royal Institution, 3. "Metals as affected by Small Quantities of Impurity," by Prof. W. Chandler Roberts-Austen, F.R.S.
— Royal Society Club, 6.30.
— Chemical, 8. "Constitution of Crude Oleic Acid as indicated by its Magnetic Rotation; and on the Magnetic Rotation of Allylacetic Acid and Diallylmalonic Ether," by Dr. W. H. Perkin, F.R.S. "On Reactions supposed to Yield Nitryl Chloride," by W. Collingwood Williams, B.Sc. "On the Conditions in which Silicon Exists in Cast-iron," by A. E. Jordan and Thomas Turner.
Friday, 19th.—Royal Institution, 9. "The Wings of Birds," by Prof. W. H. Flower, F.R.S.
— Geological, 1. (Anniversary).
— Society of Arts, 8. "Historical and Recent Famines in India," by F. C. Danvers.
Saturday, 20th.—Royal Institution, 3. "The History of Volcanic Action in the British Isles," by Archibald Geikie LL.D., F.R.S.

Just published, Second Edition, 32 mo., 1s. sewed (post free).

ALKALI TABLES: A Ready Reckoner for the Use of Chemical Merchants, Manufacturers, and Brokers. By Oswin Bell.

Crosby Lockwood & Co., 7, Stationers' Hall Court, London, E.C.

Just published, crown 8vo., 12s. 6d. cloth (postage 8d.).

ELECTRO-DEPOSITION. A Practical Treatise on the Electrolysis of Gold, Silver, Copper, Nickel, and other Metals and Alloys; with Descriptions of Voltaic Batteries, Magneto- and Dynamo-Electric Machines, Thermopiles, and of the Materials and Processes used in every department of the art; and several Chapters on Electro-Metallurgy. By Alexander Watt, Author of "Electro-Metallurgy," &c.

Crosby Lockwood & Co., 7, Stationers' Hall Court, London, E.C.

Just published, price One Shilling,

A CATALOGUE of CHEMICAL PERIODICALS. By H. CARRINGTON BOLTON, Ph.D., Professor of Chemistry in Trinity College, Hartford, Conn. First published in the *Annals of the New York Academy of Sciences*, and Reprinted from the *Chemical News*.

London: *Chemical News* Office, Boy Court, Ludgate Hill, E.C.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES, SOUTH KENSINGTON.

A Course of Fifty Lectures on ORGANIC CHEMISTRY will be delivered on Mondays, Wednesdays, and Fridays, at 10 a.m., by Dr. F. R. JAPP, F.R.S., commencing on February 15th.

The Course will treat of the various Vegetable Principles (Dyestuffs, Alkaloids, &c.), with the Mode of their Extraction; the Synthesis of some of these Principles; Compounds occurring in the Animal Organism; and the Artificial Organic Compounds of Scientific or Industrial Interest.

Stress will be laid on the theoretical bearings of the various compounds, and the methods employed in determining their constitution will be described

A detailed Syllabus of the Course may be obtained on application to the Registrar.

TO CHEMICAL MANUFACTURERS.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1369.

NOTE ON THE

SOLUBILITY OF BARIUM SULPHATE IN HYDROBROMIC AND HYDRIODIC ACIDS.

By ARTHUR R. HASLAM.

While recently engaged in the preparation of hydrobromic acid by the process now given in the British Pharmacopœia, an attempt was made to precipitate the sulphuric acid contained in the crude liquor with barium carbonate previous to distilling off the acid: on filtering the mixture it was afterwards found that the filtrate still contained traces of barium sulphate in solution. I have not been able to find any reference to, or note of, this fact, and therefore I venture to record here the following experiments, with their results:—

Pure barium sulphate was obtained by precipitating pure barium chloride with a slight excess of sulphuric acid. The precipitate was washed four or five times by decantation, and then thrown on a filter, and further washed with distilled water until all trace of acid had disappeared; it was then dried in a hot-water oven. In these experiments water distilled three times was used, 500 c.c. of which, when evaporated to dryness, gave no residue.

The hydrobromic acid used contained 40 per cent of real acid, and was prepared by immersing ordinary white phosphorus in soft paraffin, and adding bromine, which, if this method be employed, combines with the phosphorus without any fear of explosion: water was then added drop by drop, when hydrobromic acid was liberated, and may be distilled in a perfectly pure state. The well-known reaction is explained by the following equation:—

$$P+5Br+4H_2O=5HBr+H_3PO_4.$$

The same method was employed for the preparation of pure hydriodic acid, the equation in this case being—

$$P+3I+3H_2O=3HI+H_3PO_3.$$

Having thus obtained reliable acid and sulphate of barium, the solubility of the latter was found by taking 100 c.c. of hydrobromic acid in a flask, and adding 1 grm. of sulphate of barium. This was then boiled for a quarter of an hour on a sand-bath, and then filtered, receiving the clear filtrate in the 100 c.c. flask, which was then filled to the graduated mark with distilled water; this was then divided into two equal portions of 50 c.c. each, and evaporated to dryness. The residue was found to weigh in each case 0·02 grm., which represents a solubility of $\frac{1}{50}$. A similar experiment was made with hydriodic acid, which showed the sulphate of barium to be much less soluble in it than in the hydrobromic acid: the residue weighed in this case only 0·008 grm., which shows a solubility of $\frac{1}{125}$.

Dublin, February 11, 1886.

DETERMINATION OF IRON AND ALUMINA IN PHOSPHATES.

By E. W. T. JONES, F.I.C.

The following method for the above-named object has been practised by me, when needed, for the last twenty years. In my opinion it is better than the procedure described by Mr. Dyer (Chemical News, vol. liii., p. 51), because it yields a direct determination in each case with very little trouble.

Dissolve from 1 to 2 grms. of the phosphate in hydrochloric acid, evaporate to dryness, take up again with hydrochloric acid and water, filter, oxidise with nitric acid if necessary, nearly neutralise with ammonia, dilute if necessary to about 200 c.c., warm the solution, and pour into 100 c.c. of hot solution of ammonic acetate acidified with 10 c.c. of ordinary strong acetic acid; allow to stand a time for the precipitate to subside, then filter, wash with hot water, dropping on to the filter from time to time some solution of ammonic acetate; filtration and washing then proceed satisfactorily. The requisite amount of washing having been accomplished, pierce the filter and wash the precipitate into a beaker, finally clearing the filter by dropping some hydrochloric acid round it, and further rinsing; make the solution hot, nearly neutralise with some solution of pure caustic potash, and pour *into* about 50 c.c. of solution containing 4 to 5 grms. of pure KHO *boiling* in a silver dish. *Boil* a few minutes and filter, wash the oxide of iron, dissolve in HCl, reduce with stannous chloride, and titrate with standard dichromate solution. Warm the filtrate from the oxide of iron and add acetic acid till a precipitate just begins to form, and then add it to 50 c.c. of heated solution of acetate of ammonia acidified with 5 c.c. of acetic acid; allow to stand a short time, then filter and wash thoroughly with hot water, using from time to time some drops of ammonic acetate, or filtering and washing become tedious; the precipitate, being dried and ignited, is weighed as $Al'''PO_4$: in this way the orthophosphate is always precipitated, and the composition may be relied on.

To illustrate the practical applicability of the method I weighed out 2 grms. of bone-ash, dissolved in HCl and filtered, added 0·5 grm. alum and 0·5 grm. ferrous ammonic sulphate, oxidised with HNO_3 diluted to about 200 c.c., nearly neutralised with AmHO, warmed and poured into 100 c.c. of hot ammonic acetate acidified with 10 c.c. of acetic acid, and proceeded as described above. I obtained 0·0702 grm. iron against 0·0692 grm. added (the amount by careful experiment 0·5 grm. of the double salt was found to contain). Of phosphate of alumina I got 0·1270 grm.: this equals 0·0534 Al_2O_3 against 0·0580, the amount half a gramme of the alum gave by careful direct precipitation.

Two grms. of the bone-ash by itself, treated the same way, gave only 0·0050 grm. of precipitate after standing all night: this proved to be iron, and was allowed for in the above estimation.

I may mention that I weigh the alumina from iron ores as phosphate, and find the proceeding very satisfactory.

N.B. I make the ammonic acetate solution by neutralising ordinary strong acetic acid with 0·960 ammonia.

ON A

REAGENT PERMITTING THE DETECTION OF THE ACID FUNCTION OF WEAK ACIDS.

By M. R. ENGEL.

It has long been known that the neutralisation of the different acids is not manifested in the same manner by the different colouring-matters (litmus, cochineal, hæmatoxyline). The theoretical reasons in virtue of which the strong acids are recognised by their reaction upon the tincture of litmus have been developed by M. Berthelot (*Mecanique Chimique*, ii., p. 204). Subsequently M. Miller (*Berichte*, 1878, p. 460) has shown that certain salts which turn litmus blue are without action upon tropæoline. Mr. R. T. Thomson (Chemical News, vol. xlix., p. 123) has shown that orange 3 defines phosphoric acid as monobasic, whilst phenacetoline and especially phenolphthaleine define it as bibasic. M. Joly (*Comptes Rendus*, 1885, c., p. 55) has called attention to the same facts.

Lastly, M. Berthelot, by recent calorimetric experiments, has fully explained the question, showing that helianthine A characterises the neutralisation of every acid the formation-heat of whose solid potassium-salt exceeds 10·2 cals., whilst helianthine B and phenol-phthaleine enable us to titrate every acid the formation of whose solid potassium-salt exceeds 6 to 7 cals.

The soluble blue (Poirrier's CLB), a colouring-matter to which M. Ville and the author have called attention, permits the direct titration in the cold of alkaline bases in presence of their carbonates, and indicates the neutralisation of acids which evolve still less heat with potassa, though it has not been possible to fix the lower limit of this source of this quantity of heat, the potassium-salts of most of the bodies in question not being known in the solid state.

This reagent serves not merely for certain determinations, but also as a means of demonstration in lectures. It shows distinctly the acid function of certain organic compounds of mixed functions which are neutral, or even alkaline, with litmus, and with the aid of orangé 3 and of phenol-phthaleine it shows the relative thermic energy of various acids, and the several distinct energies of most polybasic acids.

Experiments have been made as follows:—Take a quantity of the substance equal to its molecular weight, to the half or to the tenth of such weight; the solution is diluted to 1 litre, so as to have normal, seminormal, or decinormal solutions, according to the solubility of the substance. These liquids are titrated with normal potassa, having added a few drops of the solution of soluble blue at $\frac{1}{100}$. To distinguish the end of the reaction it is well to operate in a beaker of Bohemian glass set on a white ground, the depth of the liquid to be titrated not exceeding a few m.m. When the last three- or four-tenths of a c.c. of the solution of potassa to be added are reached, the blue colour begins to change alike with strong and with weak acids; but on operating as just described each drop of potassa falling in the centre of the vessel gives a violet-red tint, which stands out distinctly against the general tint of the liquid. The addition of potassa is continued until a drop no longer occasions any change of colour, but merely a difference in intensity of the same colour, scarcely visible and due to the dilution of the liquid at the place where the drop falls.

1. *Phenol.*—Phenol, in presence of which litmus and orangé 3 turn at once under the influence of a single drop of potassa, and helianthine B turns progressively, behaves with the blue like a monobasic acid. Just as certain strong acids do not redden litmus in presence of alcohol, phenol in an alcoholic solution does not act upon the soluble blue if previously reddened by a drop of potassa.

2. *Resorcin* is distinctly characterised as a bibasic acid. This result is conformable to the recent experiments of MM. Berthelot and Werner on the neutralisation heat of resorcine by soda.

3. *Morphine.*—It was particularly interestin to ascertain if morphine which possesses the double phenol function manifests these functions in presence of "soluble blue." The results were most decisive. Morphine behaves like an acid; but on account of the sparing solubility of the free base the author was obliged to prepare a standard solution with its hydrochlorate: 100 degrees of a decinormal solution of morphine hydrochlorate required 24 degrees of potassa (theoretically 20 degrees for the double phenol function). Thus, for neutralisation it requires a quantity of potassa slightly greater than that indicated by theory. The author ascribes this result to a division of the hydrochloric acid between the potassa and the morphine which as a base no longer acts upon the colouring-matter. The author and M. Ville have pointed out that ammonia does not turn the soluble blue to a red. It is the same with ethylamine and the other amines, and doubtless also with morphine naturalised in its functions as phenol. However this may be, it is easy to show in a striking manner the acid function of phenol, either with the free alkaloid or its hydrochlorate.

4. *Monovalent Alcohols.*—Soluble blue is turned by a single drop of potassa in presence of monovalent alcohols, even if tertiary alcohols (trimethyl-carbinol and pinacone) are simultaneously present, which in many respects approach the phenols, but which are clearly distinguished by this character. There is room to examine the non-saturated fatty acids of the fatty series from this point of view.

5. *Polyvalent Alcohols.*—In strong solutions glycerin, erythrite, mannite, &c., show an acid tendency. Several drops of potassa are needed to reach the red tint, which may be brought back to a blue by an excess of the polyvalent alcohol, but their titration is not possible.

6. *Ordinary Aldehyd* is turned by a single drop of potassa.

7. *Chloral* is perfectly capable of titration. It behaves like a monobasic acid. As chloral when decomposing under the influence of potassa yields chloroform and a mol. of monobasic formic acid, there is no reason to inquire in this determination whether decomposition takes place or not. This method is quite practical, and may serve to show the value of a commercial chloral.

8. *Hydrocyanic Acid* may also be determined acidimetrically, using soluble blue as an indicator. The results are excellent. Glycocoll, alanine, and taurine behave as acids. The determination of these substances, which is of no interest, does not seem practicable, because towards the limit the change is effected gradually, and the colouration of the liquid tends to disappear; but the acid function of these bodies, which are at once acids and bases, is shown very distinctly.—*Comptes Rendus*, cii., p. 214.

CONTROL ANALYSES AND LIMITS OF RECOVERY IN CHEMICAL SEPARATIONS.*

By ALBERT B. PRESCOTT.

(Concluded from page 79).

FINALLY, the summary next given may be further defined, in comparison of limits of separation with limits of identification, as follows, namely: The loss in separating from an avoirdupois pound of tissues is, for arsenic, in round terms, about a thousand times the quantity needed for certain identification; and for strychnine, from one thousand to two thousand times such least quantity. For morphine, both limits are less definite, and decomposition losses interpose, and the data obtained do not warrant an assured statement. But in the results here given the loss of alkaloid, per pound of tissues, was about 100 times the quantity needed for identification.

Summary of Limits of Recovery.

(Separation of Crystalloids from Colloids).

Strychnine (24 hrs. mac.)—					
From	5 grms.	bread,	1 in	51282 parts,	qual.
,,	5 ,,	meat	,,	30769 ,,	,,
,,	50 ,,	meat	,,	125786 ,,	,,
Morphine (not mac.)—					
From	64 grms.	bread,	1 in	185185 parts,	qual.
,,	64 ,,	tissues,	,,	142857 ,,	,,
,,	64 ,,	liver,	,,	142857 ,,	,,
,,	128 ,,	tissues,	,,	19608 ,,	quant.
,,	128 ,,	liver,	,,	10870 ,,	,,
Arsenic (1) From	62 grms.	liver,	1 in	112360 parts,	quant.
(2)	,,		1 in	108695 ,,	,,
(3)	,,		1 in	188697 ,,	,,

* Read at the Ann Arbor meeting of the American Association for the Advancement of Science, August 27th, 1885.

TABLE XVII.

Salt examined.	Grms. of water to 1 of salt.	Reagent.	C.c. of Reagent.	Temp. C.	Time in minutes.	Menstruum 2 c.m. deep.	Menstruum 9 c.m. deep.
K_2SO_4	40	$CaCl_2$	10	15°	3	Slight precipitate.	Slight precipitate.
	80		5	15	5	No precipitate.	No precipitate.
	80		5	15	20	Slight precipitate.	Slight precipitate.
	80		5	100	2	Heavy precipitate.	Heavy precipitate.
	100		5	15	25	No precipitate.	No precipitate.
	120		5	15	30	No precipitate.	No precipitate.
	120		5	15	180	Marked precipitate.	Marked precipitate.
	240		5	100	5	Distinct precipitate.	Distinct precipitate.
	300		5	100	5	*Limit.*	Precipitate.
	350		5	100	5	No precipitate seen.	*Limit.*
	400		5	100	5	No precipitate.	No precipitate.

TABLE VII.

$Pb(NO_3)_2$	100	H_2SO_4	2·5	37°	0·1	Heavy precipitate.	Heavy precipitate.
	300		2·5	41	0·1	" "	" "
	400		2·5	38	0·1	" "	" "
	800		2·5	40	0·5	Precipitate.	Precipitate.
	1000		2·5	35	0·5	"	"
	2000		2·5	38	0·2	Faint precipitate.	Opaque.
	4000		2·5	38	1	" "	"
	5000		2·5	36	5	*Limit.*	"
	7500		2·5	35	5	No precipitate.	Faintly opaque.
	10000		2·5	42	5	" "	*Limit.*
	12000		2·5	29	30	" "	*Limit.*

FROM TABLES XXIX. AND XXXI.

Salt examined.	Grms. water to 1 of salt.	Reagent.	C.c. of reagent.	Precipitate formed.	Grms. of Ppt. from 1 of salt.	Temp. C.	Time, mins.	Menstruum 2 c.m. deep.	Menstruum 9 c.m. deep.	
K_2SO_4	300	$CaCl_2$	5	$CaSO_4$	0·7807	100°	5	Limit.		
	350		5			100°	5		*Limit.*	Table XVII.
$Pb(NO_3)_2$	5000	H_2SO_4	2·5	$PbSO_4$	0·9153	36°	5	Limit.		
	10000		2·5			42°	5		*Limit.*	Table VII.
	12000		2·5			29°	30		*Limit.*	

FROM TABLE XXXIII.

Precipitate.	Present in menstruum.	Temperature C.	Parts of water to 1 part of Ppt. at the limit.	"Solubilities" as quoted by Storer's "Dictionary."
$CaSO_4$	K_2SO_4 and KCl	100°	483	388 to 500
$CaSO_4$	$CaCl_2$ and KCl	100°	244	
$PbSO_4$	H_2SO_4 and HNO_3	29°	14421	13000
CaC_2O_4	$(NH_4)_2C_2O_4$,NH_4Cl	100°	24728	500000
BaC_2O_4	$(NH_4)_2C_2O_4$,$NH_4C_2H_3O_2$	100°	5462	2500

Limits of Recognisable Precipitation.

The first production of a precipitate, in a mixture made by adding one solution to another, is a constant not agreeing very closely with that of the so-called solubility of the substance precipitated. The proportion of solvent needed to dissolve a solid may differ a good deal from the proportion of the same solvent present at the incipient precipitation of the solid. In other words, the equilibrium between precipitation and solution may offer a good deal of resistance—just as the melting point may be removed some degrees from the congealing point. It is true that the factor of solubility is usually—perhaps incorrectly—defined as the ratio obtained when a supersaturated solution, left at a certain temperature for a certain time, has deposited its excess of dissolved substance. Moreoiver, the causes of variable solubility of solids are very illusive.

Results in illustration of such variability were given to this Association by the writer in 1875. Indeed our ideas of solubilities are in a suggestive stage, l ading us toward the unknown border between adhesion and chemism.

It appears to the writer that the fact of the initial appearance of a precipitate when one given solution is added to another, in stated conditions, may be taken as a constant by itself—not to be calculated from other constants but to be determined by experiment. Initial precipitation is governed by the concentration of the substance precipitated, by the presence of and concentration of other dissolved substances, and by temperature and time. That is, with temperature and time we have relations of mass too complex for calculation now, but easily made constant in experiment. Now if we fix the temperature and time, the quantity of the one solution with its components and their concentration, and fix the quantity of the other solution and know its components, then the concentration of these components becomes constant in parallel operations. In short, by controlling the given factors, a simple qualitative test may be made to show whether a required percentage is at, or above, or below a required limit. This way of using qualitative tests, with measured quantities, temperatures, and times, to reach quantitative indications, is a resource becoming more and more common in analytical work. It is made available in the later revisions of the pharmacopœias. For instance, in the U. S. Ph. "If one grm. of bitartrate of potassium be digested with 5 c.c. of diluted acetic acid for half an hour, then diluted with distilled water to 500 c.c., the solution agitated and filtered, and 25 c.c. of the filtrate treated with 5 c.c. of test-solution of oxalate of ammonium, the liquid should not become cloudy in less than one minute, nor distinctly turbid in less than one minute and

a half (absence of more than 6 per cent of tartrate of calcium)." Likewise we have the test (Kerner's) of sulphate of quinine for other cinchona alkaloids, of iodide of potassium for chloride and bromide, and of bicarbonate of sodium for monocarbonate.

Two years ago, in an inaugural thesis for the master's degree in the University of Michigan, Delos Fall reported determinations of the limits of precipitation. His work embraced 241 satisfactory experiments, defining 48 limits in formation of 24 precipitates. The limits were chiefly determined for the time of five minutes. There is a wide field for work of this character. It gives support to studies in molecular science: it fixes data of service in daily operations; and it defines factors by which a ready trial reveals required limits of strength and purity of materials. In the tests by Mr. Fall, 25 c.c. of the solution of known strength of a single salt were taken; 5 c.c. of a reagent of given strength added, in a test-tube 2 c.m. wide, and the depth of the liquid was made to be 9 c.m. The temperature was noted, and observations for incipient precipitation were taken at stated times. The beginning of precipitation was recognised, in most cases, by observing a figure of thirty-five dotted parallel lines to the inch, looking through the same depth of water to which same quantity of reagent had been added for comparison. I quote selections of Mr. Fall's tabulated reports, to present the method of investigation, and the character of the results reached. I hope he and others may continue the work, and that the whole may have publication at a future time.

ON THE TRANSFER OF COPPER THROUGH A GASEOUS STRATUM AND ON A DIRECT COMBINATION OF COPPER AND NITROGEN.

By R. BLONDLOT.

In the course of experiments undertaken with the object of studying the passage of electricity through incandescent gases the author has had the opportunity of making the following observations.

A platinum disc and a disc of copper of 0·03 metre in diameter were fixed perpendicularly opposite to each other by means of supports consisting of two platinum columns. The mutual distance of the discs was 3 or 4 m.m. The whole was placed in the interior of a glazed porcelain bell, the mouth of which, turned downwards, remained free.

The apparatus having been raised to a bright red heat for about three hours by heating the bell from above by means of a gas-furnace, it was perceived, in the absence of any electric current, that the surface of the platinum disc turned towards the copper had totally changed its aspect—there was formed on it a coating of about $\frac{1}{15}$ m.m. in thickness having the colour of graphite. Having scraped off a portion of this layer by means of a fragment of glass the author found that it was insoluble in cold nitric acid but soluble in this acid if heated, leaving, however, a residue of a black powder. The dissolved portion contained considerable quantities of copper, though the platinum of the disc contained mere traces. The black powder was very active platinum black.

Thus there had taken place the formation, at a distance, of a chemical compound containing copper and platinum. That is to say the copper had traversed the interval which separated the two discs. As often as the experiment was repeated it yielded the same result.

In this experiment the copper was strongly oxidised. To decide whether or not this oxidation played a part in the phenomenon the experiment was repeated in pure nitrogen. A porcelain tube, glazed within and without, had cemented to its two extremities metallic fittings, kept constantly cooled by the circulation of water. To each of them was fixed a platinum column, directed towards the interior of the tube along its axis. These two columns were terminated respectively by discs of platinum and copper, which were thus placed opposite to each other in the middle of the tube. A slow current of pure nitrogen prepared by Schlœsing's method was passed slowly into the tube for twelve hours and the tube was then heated to bright redness for four or five hours. The transference of copper was invariably observed and at the same time the copper disc was evidently corroded. Its surface remained perfectly brilliant, but it showed the uncovered facets of an internal crystallisation. It was inferred from this experiment that oxygen played no part in the phenomenon.

To ascertain if it was the same with nitrogen the experiment was repeated in pure hydrogen. The result was always negative. The experiment, repeated several times, under the most favourable conditions never gave rise to the slightest transfer. It is therefore nitrogen which plays the principal part in the transfer of the copper. In all probability there is formed a direct compound of nitrogen and copper, which is either directly incorporated in its totality with the platinum or is decomposed on contact with the latter, yielding to it its copper.

The author has found that the copper-compound deposited upon the platinum can be dissociated under the influence of a very elevated temperature. Having had occasion to heat in nitrogen a column of platinum covered with the copper compound, he found that this latter was transferred from the hottest up to the coldest parts of the column. The existence of the dissociation is further confirmed by the following fact. On operating in an open bell, according to the first process indicated, whilst the surface of the platinum turned towards the copper was covered with a thick layer of the copper compound, the posterior surface was bare. The platinum columns which serve as supports are likewise deprived of it at their upper part, whilst they are abundantly coated below. This distribution is thus explained: In the interior of the bell, the temperature being very high, the tension of dissociation is very great, and the compound cannot be formed save in the immediate neighbourhood of the source of the copper. On the contrary, towards the bottom the temperature is lower, and the compound may be formed on the lower part of the columns.—*Comptes Rendus*, vol. cii., p. 210.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JANUARY 31ST, 1886.

By WILLIAM CROOKES, F.R.S.,

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To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, February 7th, 1886.

SIR,—We submit herewith the results of our analyses of the 177 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 177 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

Despite the flooded state of the rivers, consequent on the thawing of the late heavy fall of snow, there was not any appreciable increase in the proportion of organic matter present in the water-supply of the month; the mean amount of organic carbon found in the Thames-derived supply being 0·183 part in 100,000 parts of the water as against a mean amount of 0·170 part in the preceding month. The increased storage capabilities and improved filtering arrangements now available to the Companies, seem to have rendered the effects of the varying state of the river itself, for the most part, far less marked than was commonly noticeable even but a few years ago.

The general result of our daily examinations of the water-supply of the Metropolis, carried on now for a period of five years, has been to establish its uniformly excellent state of aëration, and its habitual and increasing degree of freedom from turbidity, colour, and excess of organic matter. As regards the uniformly complete state of aëration of the water, considering its high character in this respect to be now established beyond question, we have deemed it unnecessary to continue any longer our determinations and records of the quantities of free or dissolved oxygen present per gallon.

For some time past we have been directing our attention to the examination of the water of the Metropolis by so-called biological methods, from the application of some of which, at any rate, results of importance may doubtless be ultimately arrived at; but several months at least may be expected to elapse before we shall be in a position to include any results furnished by this manner of examination in our ordinary reports. In justification of our caution in the matter, we think it only right to observe that the chief authorities in bacteriology in this country are not satisfied as to the trustworthiness even of the methods of biological examination, as yet practised by chemists; while having regard to the fact that every breath of air we draw is laden with so-called germs, they look upon the estimation of the number of germs in a given volume of water, irrespective of any determination of the beneficent or pathogenetic nature of these germs, as a result from which no hygienic inference of any kind can be drawn.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.*

By P. T. CLEVE.

(Continued from p. 82).

Carbonate of Samarium and Ammonium, $Sm,NH_4,2CO_3 + 2H_2O$.

The voluminous and amorphous precipitate which carbonate of ammonium gives with the nitrate of samarium changes after some time into a heavy powder consisting of small rounded granules, provided it be left at the ordinary temperature in presence of an excess of carbonate of ammonium. Only a trace of samarium remains in the solution. Heated to 100° the salt loses water and ammonia. The compound was pressed between filter-paper and analysed.

0·8269 grm. was dissolved in hydrochloric acid and precipitated with tetrachloride of platinum, when 0·6224 grm. $(NH)_2PtCl_6$ was obtained. From the filtrate the platinum was precipitated with H_2S and 0·4368 grm. Sm_2O_3 obtained as oxalate.

In per cent—

		Calculated.	
Sm_2O_3	52·82	348	53·70
$(NH_4)_2O$	8·81	52	8·02
CO_2	—	176	—
H_2O	—	72	—
		648	

Carbonate of Samarium and Sodium, $Sm,Na,2CO_3 + 8H_2O$.

The nitrate of samarium gives with an excess of carbonate of sodium a voluminous and amorphous precipitate which soon changes into a yellowish white powder consisting of microscopic crystalline aggregates. Only small traces of samarium remain in the solution. The salt was pressed between filter-paper and analysed. Heated in air-bath to 100° the compound loses 6 mols. H_2O (found 24·54 and 24·69; calculated 24·71 per cent).

0·4360 grm. gave 0·1751 grm. Sm_2O_3 and 0·0651 grm. NaCl.

In per cent—

		Calculated.	
Sm_2O_3	40·16	348	39·82
Na_2O	7·91	62	7·09
CO_3	—	176	—
H_2O	—	288	—
		874	

Borate of Samarium, $SmBO_3$.

Borax at a white heat easily dissolves the oxide of samarium and gives a topaz-coloured glass, from which, when completely saturated with the oxide, and after heating to a red heat, very thin micaceous brilliant microscopic scales separate. After cooling the glass was reduced to a coarse powder and treated with dilute hydrochloric acid, which left the borate as a chalk-like powder. The borate is readily soluble in hydrochloric acid, especially on heating, so that the isolation of the borate from the excess of borax-glass requires very careful treatment.

0·9137 grm. was dissolved in hydrochloric acid, the solution repeatedly evaporated and finally mixed with oxalic acid. After igniting the oxalate 0·7602 grm. Sm_2O_3 was obtained.

1·8695 grm. gave 1·5557 grm. Sm_2O_3.

In per cent—

			Calculated.	
Sm_2O_3	83·20	83·21	174	83·25
B_2O_3	(16·80)	(16·79)	35	16·75
	100·00	100·00	209	100·00

Specific gravity—

1·4490 grm., t° 16·4°, sp. gr. 6·045
1·4226 „ „ „ 6·052

Mean of both determinations, 6·048.
Molecular volume, 34·6.

Sum of the molecular volume of Sm_2O_3 and B_2O_3, divided with 2 = 40·0.

Orthophosphate of Samarium, $SmPO_4$.

This phosphate was obtained by dissolving the oxide of samarium in melting metaphosphate of sodium. A topaz-

* Presented to the Royal Society of Sciences of Upsala, Feb. 13, 1885.

coloured glass was thus produced which on cooling became enamel-like, owing to the formation of small, but well formed, short prismatic crystals. The mass was treated with water, the crystals being thus obtained as a heavy crystalline whitish yellow powder. The salt is scarcely attacked by boiling nitric acid. In order to analyse it the salt was decomposed by fusion with soda. Some phosphoric acid always remains with the oxide of samarium, so it is quite indispensable to dissolve the oxide in nitric acid and to precipitate with oxalic acid.

0·7840 grm. gave 0·5591 grm. Sm_2O_3 and 0·3311 grm. $Mg_2P_2O_7$.

0·6114 grm. gave 0·4354 grm. Sm_2O_3.

0·3400 grm. gave 2·5365 grm. phospho-molybdate of ammonia.

In per cent—

				Calculated.	
Sm_2O_3	71·31	71·21	—	174	71·02
P_2O_5..	27·01	—	27·83	71	28·98
				245	100·00

Specific gravity—

1·3611 grm., t° 17·5°, sp. gr. 5·830
1·1194 „ „ „ 5·826
Mean of both determinations, 5·828.
Molecular volume, 42.

Disodium orthophosphate gives with nitrate of samarium a bulky, white, and amorphous precipitate which can only be washed with difficulty and easily passes through the filter. When dried it forms white hard pieces. The precipitate, dried in the air at ordinary temperature, gave on analysis :—

0·4203 grm. lost at 100° 0·0290 grm. and in red hot 0·0317 grm. It gave, melted with carbonate of sodium, 0·2494 grm. Sm_2O_3 and 0·1760 grm. $Mg_2P_2O_7$.

In per cent—

	Dried in the air.	Dried at 100°.
Sm_2O_3	59·34	63·74
P_2O_5	26·78	28·77
H_2O	14·44	8·10
	100·56	100·61

The simplest formulæ which correspond to this composition are :—

		$SmPO_4 + 2H_2O$.		$SmPO_4 + H_2O$.	
Sm_2O_3	174	61·92	174	66·16
P_2O_5..	71	25·27	71	27·00
H_2O..	36	12·81	18	6·84
	281	100·00	263	100·00

The differences between the numbers found by analysis and those calculated from the formulæ are considerable, but one could not expect better from a substance such as the amorphous phosphate, the composition of which may vary. In any case the composition indicates that the precipitate which disodium orthophosphate gives with salts of samarium is principally composed of trimetallic phosphate.

Pyrophosphate of Samarium,

$$\left.\begin{matrix}Sm\\H\end{matrix}\right\}O_4,P_2O_3+3\tfrac{1}{2}H_2O.$$

Pyrophosphoric acid easily dissolves the hydrate of samarium, and the solution deposits after some time, on spontaneous evaporation, small compact granules of densely crowded crystals. The salt loses at 100° 10·79 per cent H_2O, corresponding to 2 mols. H_2O (calc. 9·28 per cent).

0·4456 grm. salt, pressed between filter-paper, lost on ignition 0·0800 grm. H_2O.

0·4118 grm. was dissolved in nitric acid and the solution boiled. On adding oxalic acid 0·1852 grm. Sm_2O_3 was thrown down as oxalate. From the filtrate 0·2348 grm. $Mg_2P_2O_7$ was obtained.

In per cent—

		Calculated.	
Sm_2O_3	44·97	348	44·84
P_2O_5..	36·47	284	36·60
H_2O	17·95	144	18·56
	99·39	776	100·00

Anhydro-metaphosphate of Samarium, $Sm_2O_3 5P_2O_5$.

If the anhydrous and finely-powdered sulphate of samarium be added to fused metaphosphoric acid it dissolves easily, fumes of sulphuric acid being given off. The residue soon becomes white owing to the formation of small crystals. After cooling the mass was treated with water, which dissolved the phosphoric acid and left a heavy yellowish white powder of small glittering crystals insoluble in water and in boiling nitric acid. The crystals were very well developed. They represent a new series of phosphates. Didymium gives an exactly analogous phosphate.

0·6425 grm. was fused with soda and the fused mass treated with water. The solution was precipitated with magnesia-mixture and the residue dissolved in nitric acid and precipitated with oxalic acid. By igniting the oxalate 0·2150 grm. Sm_2O_3 was obtained. The filtrate from the oxalate contained phosphoric acid, which was precipitated as ammonium-magnesium phosphate. Altogether 0·6678 grm. $Mg_2P_2O_7$ was obtained.

0·9672 grm. gave 0·3195 grm. Sm_2O_3 and 1·0138 grm. $Mg_2P_2O_7$.

In per cent—

	I.	II.	Calculated.	
Sm_2O_3	33·46	33·03	174	32·89
P_2O_5	66·48	67·04	355	67·11
	99·94	100·07	529	100·00

Specific gravity—

1·0145 grm., temp. 28·8°, sp. gr. 3·485
0·9965 „ „ „ 3·489
Mean of both determinations, 3·487
Molecular volume, 151·7.

Vanadates of Samarium.

The neutral solutions of the salts of samarium and alkaline metavanadates give a light yellow perfectly amorphous precipitate consisting for the greater part of hydrated orthovanadate of samarium. The numbers found on analysis did not agree sufficiently well with those calculated to make me think it worth publishing them. If a solution of bivanadate of sodium be mixed with a solution of the nitrate of samarium, a yellowish amorphous precipitate is thrown down, probably the orthovanadate of samarium, and from the filtered solution on spontaneous evaporation at the ordinary temperature two different sets of crystals are obtained. The one set has the colour of bichromate of potash, and the other a more yellow colour. Both form large, extremely beautiful crystals.

A. *The Red Salt*, $Sm_2O_3,5V_2O_5+28H_2O$.

0·3760 grm. lost, on heating to 100°, 0·0864 grm. H_2O, and at incipient redness 0·0196 grm. more. The anhydrous salt was dissolved in HCl and reduced with SO_2. On adding oxalic acid and igniting the oxalate 0·0726 grm. Sm_2O_3 was obtained. The filtrate from the oxalate of samarium was evaporated to dryness, and the residue carefully heated so as to volatilise the excess of oxalic acid. It was then oxidised with very dilute nitric acid, evaporated to dryness, and heated so as to melt the vanadic acid, the weight of which was found to be 0·1953 grm., but which, however, contained 0·0027 grm.

Sm_2O_3. The analysis had thus given 0·1926 grm. V_2O_5 and 0·0753 grm. Sm_2O_3.

In per cent—

		Calculated.	
Sm_2O_3	20·03	348	19·75
V_2O_5	51·22	910	51·65
H_2O at 100°	22·98	504	28·60
H_2O at red heat	5·21		
	99·44	1762	100·00

Specific gravity—

0·8846 grm. large crystals, temp. 17·5°, sp. gr. 2·522
0·8702 „ „ „ 17·8°, „ 2·526

Mean of both determinations, 2·524
Molecular volume. 1762/2·524 = 698.

B. *The Yellow Salt*, $Sm_2O_3,5V_2O_5 + 24H_2O$.

0·3833 grm. lost at 100° 0·0781 grm., and at a red heat 0·0217 grm. H_2O in addition. The anhydrous salt was treated as described above, and gave 0·0794 grm. Sm_2O_3 and 0·2041 grm. V_2O_5.

In per cent—

		Calculated.	
Sm_2O_3	20·71	348	20·59
V_2O_5	53·25	910	53·85
H_2O at 100°	20·37	432	25·56
H_2O at red heat	5·66		
	99·99	1690	100·00

Specific gravity—

0·5851 grm. large crystals, temp. 17·5°, sp. gr. 2·628
0·5852 „ „ „ 17·8°, „ 2·620

Mean of both determinations, 2·624.
Molecular volume, 1690/2·624 = 644.

Molybdate of Samarium, Sm_23MoO_4.

A neutral solution of the nitrate of samarium gives with an excess of molybdate of ammonia ($6NH_4,Mo_7O_{24}$) a voluminous white precipitate which, if warmed, is changed into a heavy granular non-crystalline powder. Much samarium remains in solution. As the salt was amorphous it was not subjected to analysis. In order to obtain crystalline molybdate calculated quantities of molybdic acid and oxide of samarium ($Sm_2O_3 : 3MoO_3$) were mixed with pure chloride of sodium and heated in a large platinum crucible for some hours to bright red heat. After cooling the mass was treated with water, which left 1:0 heavy violet-coloured very brilliant crystals, 2:0 fine microscopic needles, and 3:0 brilliant scales, resembling boracic acid, insoluble in ammonia and slowly soluble in hydrochloric acid; of 3 only a small quantity insufficient for analysis was obtained. The two other sets of molybdates could be pretty completely separated by elutriation. The heavy crystals were neutral molybdate of samarium and the light needles (2) a molybdate of samarium and sodium.

The molybdate of samarium, Sm_23MoO_4, formed small rhombic octahedrons and combinations of the horizontal and vertical prisms. Some crystals attained a length of ¼ to $\frac{1}{10}$ of a millimetre. They had a diamond lustre and a dark violet colour, occasioned by a trace of molybdic oxide. Heated in the air they became white. They were very slowly decomposed by hydrochloric acid. The sp. gr. was 5·95, but this number is only approximate as the salt was not pure. The analysis gave 47·4 per cent Sm_2O_3 instead of 44·62 per cent.

Molybdate of Samarium and Sodium, $SmNa2MoO_4$.

As described above, thin microscopic needles of this salt were obtained along with the neutral molybdate of samarium by fusing molybdic acid and oxide of samarium with chloride of sodium. Separated from the neutral salt by elutriation it formed a voluminous woolly mass of a dirty violet colour, which colour disappeared on gently heating in the air. Warm dilute hydrochloric acid dissolves this salt easily.

0·4402 grm. gave 0·1518 Sm_2O_3 and 0·0597 grm. NaCl.

In per cent—

		Calculated.	
Sm_2O_3	34·48	174	35·29
Na_2O	7·19	31	6·29
MoO_3	(58·33)	288	58·42
	100·00	493	100·00

Sp. gr. = 5·265 at 18° as mean of two determinations. As the salt was not perfectly pure this number may be regarded as only an approximation.

Tungstate of Samarium and Sodium, $Sm_4Na_69WO_4$.

Was obtained by Mr. Högbom,* who heated tungstic acid with a corresponding quantity of the oxide of samarium in an excess of chloride of sodium. The salt forms brown microscopical crystals. The analysis gave:

		Calculated.
Sm_2O_3	25·62	23·43
Na_2O	6·10	6·26
WO_3	68·16	70·31

The salt contained as impurity a little of oxide of samarium.

Metatungstate of Samarium.
$Sm_2O_3,12WO_3 + 35H_2O$.

Metatungstate of barium was decomposed with a calculated quantity of sulphate of samarium and the solution evaporated over oil of vitriol. From the very concentrated solution large topaz-yellow and well-formed crystals were obtained. The salt is easily soluble, but not deliquescent. It becomes opaque when exposed to light. It loses at 100° 12·21 per cent H_2O, or 25 mols. H_2O (calc. 11·96).

I. 1·4985 grm. salt, pressed between filter-paper, lost, on heating nearly to redness, 0·2510 grm. H_2O, and gave on decomposition with concentrated sulphuric acid 1·0995 grm. WO_3. From the filtrate from the tungstic acid 0·1394 grm. Sm_2O_3 was precipitated as oxalate.

II. 1·1556 grm. lost on heating 0·1951grm. H_2O, and gave, when decomposed with hydrochloric acid, 0·8504 grm. WO_3 and 0·1088 grm. Sm_2O_3 precipitated as oxalate.

In per cent—

	I.	II.	Calculated.	
Sm_2O_3	9·30	9 41	348	9·25
WO_3	73·37	73·59	2784	74·00
H_2O	16·75	16·88	630	16·75
	99·42	99·88	3762	100·00

Specific gravity—

2·5007 grm. large crushed crystals, temp. 18·2° sp. gr. 3·996
2·3130 „ „ „ 18·4° „ 3·992

Mean of both determinations, 3994.
Molecular volume, 941·9.

(To be continued).

Action of Tannin in Fehling's Liquor.—A. Sonnenschein.—If the sugar in wines is determined by Fehling's solution, tannin, if present, and probably other substances, will be estimated as sugar.—*Dingler's Journal.*

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* *Bull. Soc. Chim.*, xlii., 5. *Ofversigt af K. Sv. Vet. Akad. Förh*, 1884, No. 5, p. 120.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, February 13th, 1886.

Prof. F. GUTHRIE, President, in the Chair.

PROF. T. H. Huxley and Mr. A. E. Mills were elected Members of the Society.

The PRESIDENT read the Report of the Council.

The Treasurer, Dr. E. ATKINSON, presented his Report, which was adopted.

The Meeting resolved that votes of thanks be accorded to—

The Committee of the Council of Education;
The President and Officers of the Society;
The Auditors of the Society's accounts.

The Meeting then proceeded to elect Officers for the forthcoming year, and a ballot having been taken the following were declared elected:—

President—Dr. Balfour Stewart, LL.D., F.R.S.

Vice-Presidents—Dr. J. H. Gladstone, F.R.S.; Prof. G. C. Foster, F.R.S.; Prof. W. G. Adams, F.R.S.; Sir W. Thomson, D.C.L., F.R.S.; Prof. R. B. Clifton, M.A., F.R.S.; Prof. F. Guthrie, Ph.D., F.R.S. (the above have filled the office of President); Prof. W. E. Ayrton, F.R.S.; Shelford Bidwell, M.A., LL.B.; Prof. H. McLeod, F.R.S.; Prof. W. Chandler Roberts-Austen, F.R.S.

Secretaries—Prof. A. W. Reinold, M.A., F.R.S.; and Walter Baily, M.A.

Treasurer—Dr. E. Atkinson.

Demonstrator—C. Vernon Boys.

Other Members of Council—Conrad W. Cooke; Prof. G. Forbes, F.R.S.E.; Prof. F. Fuller, M.A.; R. T. Glazebrook, M.A., F.R.S.; J. Hopkinson, D.Sc., F.R.S.; Prof. J. Perry, F.R.S.; Prof. J. H. Poynting, M.A.; Prof. A. W. Rücker, M.A., F.R.S.; Prof. S. P. Thompson, D.Sc.; C. R. Alder Wright, D.Sc., F.R.S.

Professor GUTHRIE, in resigning the position of President, thanked his colleagues for the help they had afforded him since he became President of the Society in 1884. He also congratulated the Society upon the highly satisfactory state to which it had attained.

The Meeting then resolved itself into an Ordinary Meeting.

In the absence of the President, Prof. Balfour Stewart, the chair was occupied by Prof. G. C. FOSTER.

The following communications were read:—

"*On Experimental Error in Calorimetrical Work*," and "*On Delicate Calorimetrical Thermometers.*" By Prof. S. U. PICKERING.

In conducting a great number of determinations of the heat of dissolution of a solid body in water, the author has had an opportunity of detecting the sources of error incident on such work, and by an examination of the results has not only obtained the mean error of a series of observations, but has been able to apportionate this error to its various causes. In the experimental work it was found that the presence of anything but air between the calorimeter and jacket was most injurious; the space should be entirely open, and no cover of any sort should be used. Before reading the thermometers, as pointed out by Berthelot, the top of the stem should be tapped for some time, otherwise the mercury lags behind the true temperature; but besides this thermometric error, which the author calls the "temporary error," is another effect which may be termed the permanent error, of a similar kind, which no amount of tapping will remove. He has found and verified by special experiments that a thermometer when rising is invariably too low, while when falling it is invariably too high. The error due to this, which varies in amount with different instruments, is avoided by conducting the whole experiment with a rising or with a falling thermometer. The thermometers employed in these experiments had a range of 15° C. and a total length of 600 m.m. The experiments were performed at temperatures varying from −1° to 26° C., and, as it was important that the same thermometer should be used in different experiments, and even advisable to use the same part of the scale of the thermometer, the following expedient was devised:—The thermometer was first heated to the highest temperature required in the experiment, and by the application of a flame to the mercurial column, just below the enlarged space at the end of the tube, that part of the mercury above the flame was broken off and driven into the space where it remained when the thermometer was cooled. By this means the relative value of a scale division was only inappreciably affected, while the absolute value could be obtained from a single comparison with a standard. From an examination of the results obtained, the author concludes that for further accuracy in this kind of work we must look for improvements in the methods employed, the instruments having, he believes, attained to a state as near perfection as possible.

"*On some New Forms of Calorimeters.*" By Prof. W. F. BARRETT.

These instruments were constructed for accurate and ready determinations of specific heats, notably those of liquids. In the first form the bulb of a thermometer is blown into the form of a cup, of about 4 c.c. capacity, which thus acts as a calorimeter. Into this cup the liquid is dropped directly from a burette, its temperature being observed by a thermometer in the burette, the mouth of which is closed by the end of the bulb of the thermometer, which is ground, and thus acts the part of a stopper, so that on raising the thermometer the liquid flows from the burette into the cup. The thermometer itself forms a balance; the horizontal stem acting as the beam is supported by a knife edge, and a pan is attached to the further end by the addition of weights to which the weight of liquid added can be ascertained. In the second form a simple thermometer with a large bulb is used, the latter dipping into a silver vessel into which the liquid is introduced as before.

Prof. S. P. THOMPSON exhibited a glass calorimeter, similar in construction to that of Favre and Silbermann; water is used instead of mercury, the great density of which renders it unsuitable for use in so large a glass vessel.

NOTICES OF BOOKS.

Chemical Equilibrium, the Result of the Dissipation of Energy. By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry in the University of Cambridge. Cambridge: Deighton, Bell, and Co. London: G. Bell and Sons.

THE theory of matter here put forward is avowedly an outcome of the vortex theory, with which it must stand or fall. Prof. Liveing has found in his practical experience that the notion of impenetrable atoms adhering together is "a great hindrance to the acceptance of any views of chemical action founded on sound mechanical principles," and he accordingly makes the present attempt. He seeks to show that it is a consequence of the law of dissipation of energy that given elements, if brought together, should arrange themselves in certain groups of combination. To the pure chemist—as distinguished from the physicist and from what we may call the physico-chemist—the author's views will be made most clearly apparent on examining the last chapter. Here we find it argued that chemical combination is due not to "bonds which have to be untied from one union before they can be tied together again in a new one, nor yet to any special force of chemical affinity peculiar to each element, and satisfied,

whatever that may mean, or disappearing in its combinations." To Prof. Liveing, on the contrary, combination consists "in a harmony of the motions of the combined atoms in virtue of which they move and vibrate together, and that such harmony is brought about by the general force in Nature which compels to an equal distribution of energy throughout the universe. For the notion that the variety of parts which one element can play in combination depends on the variety of modes of vibration which it is capable of taking up, a certain amount of confirmation seems to accrue from spectral observations. Thus elements simple in their chemical relations, such as hydrogen and sodium, give the least complex spectra. Those, on the contrary, which show the greatest changes of valency and play the most varied parts in combination, display the most complicated spectra."

The author asks—"If we attribute combination to an attractive force, how is it possible to explain the fact that it appears to attract one atom of hydrogen to one atom of chlorine, but not two atoms of hydrogen to two of chlorine? How is it that chlorine shows no attraction either for chlorine or hydrogen when it is already combined with hydrogen? Again, why does one atom of oxygen attract two atoms of hydrogen, but show little attraction for one atom?" Such questions, which a little reflection will allow the reader to multiply, are certainly far more easily asked than answered.

Chemical elements, it is here suggested, need not differ in substance one from another, but only in the magnitude and form of structure of their atoms. The author compares hydrogen and oxygen to two bells, made indeed of the same metal, but giving out different notes. Thus the possibility of the chemical combination of two atoms will depend on the possibility of a complete harmony in their movements.

As regards equivalence it is pointed out that this term is used in senses not precisely identical. Thus the equivalence of 1 part hydrogen to 23 parts sodium, 12 magnesium, or 28 ferrosum, is not the same thing as the equivalence of any one of these for 35·5 parts chlorine. If it is said that these same quantities are equivalent to 8 parts of oxygen we have equivalence of a third order, and when we pronounce these several quantities equivalent to 4⅔ parts of nitrogen, or to 3 of carbon, we have a fourth.

The author's object in his present work, which is evidently of a preliminary nature, is not so much to prove his theory as to show that it is, at least, not incompatible with the general principles of chemistry, and, it may be added, to point out that the accepted theory, upon close scrutiny, is by no means free from difficulties. All who are not content to accept the reputed "elements" as ultimate facts will find this book worthy of careful study.

CORRESPONDENCE.

A BENEVOLENT FUND.

To the Editor of the Chemical News.

Sir,—The lamented death recently of two chemists both unhappily leaving widows and children unprovided for suggests strongly the advisability of raising among chemists a permanent fund for the purpose of meeting the needs of such distressing cases. This might well be done under the auspices of the newly chartered Institute of Chemistry. The existing very influential committee of gentlemen belonging to that Institute now called together to further the appeals on behalf of one of the cases affords an unusual opportunity for carrying the project to a successful issue. The existence of such a fund would not stop the flow of benevolence towards cases of special necessity, but would ensure valuable help being rapidly afforded, not only to the families of younger men to whom Providence had denied a life long enough for them to "make a name" or to provide for the wants of those they left behind, but to assist individually those chemists who from various circumstances might find themselves destitute towards Life's evening, after a laborious struggle with the world. I should be happy to subscribe £10 towards such a fund and to add a small annual donation. —I am, &c.,

CHARLES H. PIESSE, F.I.C., &c.,

115, Strand, W.C., Feb. 13, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 5, February 1, 1886.

Thermic Researches on Hypophosphoric Acid.—A. Joly.—The author compares the thermic properties of the two hydrates of hypophosphoric acid with those of the several hydrates of phosphoric and arsenic acids.

Indicators of the various Energies of the Polybasic Acids.—R. Engel.—The author makes a further investigation on the use of Poirrier's blue CLB as an indicator. All the known indicators in presence of boric acid turn under the influence of potassa before the complete neutralisation of the acid. Borax behaves like an alkali with litmus, orangé 3, phenacetolin, and phenolphthaleine (CHEMICAL NEWS, xlvii, p. 135). Soluble blue, on the contrary, only begins to change colour after the complete neutralisation of boric acid. It even indicates the tendency of this acid to combine with a second mol. of potassa. Borax, though alkaline with all other coloured reagents, is acid to soluble blue. Phosphoric acid, monobasic in presence of orangé 3, and bibasic with phenolphthaleine, appears tribasic with soluble blue. As the alkaline tribasic phosphates are readily decomposed by water the change takes place gradually towards the end. Disodic phosphate is alkaline to litmus and orangé 3, neutral to phenol-phthaleine and acid to soluble blue. Arsenic acid behaves like phosphoric acid. Phosphorous acid is monobasic with orangé 3 but bibasic with soluble blue and phenol-phthaleine. Hypophosphorous acid manifests only a bibasic biacid tendency. Carbonic acid is bibasic with soluble blue, so that, *e.g.*, potassium bicarbonate, which is alkaline to litmus and orangé 3, may be titrated in presence of soluble blue with a solution of potassa, like an acid. Salicylic acid is monobasic with all reagents, like lactic acid. With its isomers, the meta- and para-oxybenzoic acid, the case is different. Whilst salicylic acid does not show its phenol function with any reagent its isomer, para-oxybenzoic acid, is monobasic with litmus and bibasic with soluble blue.

Studies on Chlorophyll.—Victor Jodin.—The author finds experimentally that when the physiological integrity of a leaf is sacrificed the action of light upon it is merely destructive of chloryphyll and provocative of oxidation.

Justus Liebig's Annalen der Chemie, Vol. ccxxxi, Part 3.

Communications from the Chemical Laboratory of the University of Tübingen.—These include memoirs by H. Spindler on the exchange of chlorine, bromine, and iodine between organic and inorganic haloid compounds, by C. Kerez on the action of the haloid compounds of aluminium upon haloid-substituted hydrocarbons, and by E. Lellmann and C. Klotz upon dichlortoluoles and dichlorbenzoic acids.

The Action of Hydrogen Phosphide upon Solutions of Metallic Salts.—Paul Kulisch.—This action takes two directions. Either the metallic salts are reduced (cupric chloride to cuprous chloride, thallous oxide to metallic thallium, gold chloride to metallic gold, ferric chloride to ferrous chloride) or the hpdrogen phosphide is transformed with the metallic salts to metallic phosphides, as in the case of cuprous chloride and bismuth salts. In most cases both reactions take place simultaneously, so that we obtain mixtures of metals and metallic phosphides. This result is demonstrated in case of the solutions of copper sulphate, the ammoniacal copper solutions, and the salts of silver, cobalt, and nickel. In other cases (lead and cadmium) the composition of the precipitate indicates mixtures of free metal and of a phosphide, but these constituents have not been separated, nor, indeed, demonstrated with certainty. The phosphides obtained by passing hydrogen phosphide into metallic solutions are very readily oxidised, especially in a moist state. Their other properties fluctuate greatly. They are all decomposed by strong acids with the liberation of hydrogen phosphide of the kind not spontaneously inflammable. Cadmium phosphide, however, forms an exception. The action of hydrogen phosphide upon metallic salts is in general very slow, owing to its sparing solubility in water. In certain cases, *e.g.* thallium, the action becomes perceptible only in the course of some hours. The salts of silver form an exception.

On Terephthal-aldehyd.—W. Löw.—Terephthal-aldehyd behaves in general like a double benzaldehyd, but in certain cases, when in the substitution of one aldehyd group the new molecular structure acquires an especial firmness, the properties of the second aldehyd group do not come into play in their full extent. Instances are terephthal-aldehydic acid, aldehyd-cinnamic acid, and aldehyd-malachite green.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 1, January, 5, 1886.

Action of Copper upon Aqueous Solutions of Sulphurous Acid.—M. Cause.—Copper belongs to the class of metals reputed as not decomposing water at the ordinary temperature in presence of acids. This decomposition, however, can be effected and copper found to behave like iron and zinc if nascent hydrogen can effect a secondary reaction such as a reduction. To prove this fact the author adds copper to an aqueous solution of sulphurous acid. After some time hydrogen sulphide is found to be present.

No. 2, January 20, 1886.

On Sodium and Potasssium Racemates, and on the Causes which determine the Splitting-up of certain Racemates.—G. Wyrouboff.—The author calls in question the hypothesis of M. Pasteur, that the racemates are split-up only under the influence of organic germs diffused in the atmosphere, and that such splitting-up ceases to take place if we operate in an atmosphere freed from organised beings. This hypothesis, the author holds, explains nothing. Why do these germs attack only a very limited number of the racemates? What is their mode of action? Why does their action cease at certain temperatures different for each salt? All the racemates except those of sodium and ammonium, of sodium and thallium, and of sodium and potassium, are less soluble at mean temperatures than the corresponding tartrates, and cannot therefore split-up. But it does not follow that their splitting-up is impossible at all temperatures. A racemate is not a simple mixture of the two tartrates: it has a distinct individuality, and it has always a different hydratation from that of the tartrates into which it splits up.

The Neutralisation of the Aromatic Acids.—M. Berthelot.—The author's thermic determinations relate to the mellic, meconic, and acrylolactic acids. The neutralisation-heat of true acidity oscillates about +13 cals. for the most varied organic acids.

Researches on Isomerism in the Aromatic Series. Neutralisation-Heat of the Oxybenzoic Acids.—MM. Berthelot and Werner.—Already mentioned.

On Isomerism in the Aromatic Series. On the Oxybenzoic Acids, and on their Formation- and Transformation-Heats.—MM. Berthelot and Werner.—The reciprocal transformation of isomers of the same chemical function gives rise only to feeble thermic effects, and consequently to a work relatively very small compared with that which corresponds to combinations, properly so called, to polymerisations, and to changes of real function.

Researches on Isomerism in the Aromatic Series. Action of Alkalies upon Phenols of a Mixed Function.—M. Berthelot.—The author's results show a perfect harmony between thermic indications and chemical theories relating to complex phenolic functions.

On Various Phenols.—M. Berthelot.—Alizarin in a very dilute solution only manifests towards the alkalies one of its two characteristic phenolic functions. It behaves in this respect like pyrocatechine, and like various simple phenols (pyrogallol and phloroglucine), or mixed (salicylic acid), of the ortho-series.

Pyrogenous Decomposition of the Acids of the Fatty Series.—M. Hanriot.—The author, after studying the succinic, adipic, glycolic, lactic, and pyruvic acids, finds that they are all split-up in a very simple manner with the loss of carbonic acid. Glycolic acid forms an exception, and the profound decomposition which it undergoes seems to depend on the elevated temperature of the reaction.

Continuous Preparation of Oxygen by means of Calcium Chloride and Cobalt Oxide.—A. Bidet.—The author has devised an apparatus for working out this process, a figure of which is given.

Detection of Acetone in Liquids, especially in certain Pathological Cases.—P. Chautard.—The author dissolves ¼ grm. of magenta in ½ litre of water, and passes into it a current of sulphurous acid. The liquid takes a very pale yellow colour, and may be preserved indefinitely in a stoppered bottle. To detect acetone in urine it is sufficient to pour into a test-tube, containing from 15 to 20 c.c. of the urine, 1 c.c. of the reagent above mentioned. If acetone is present a violet colouration is produced.

Action of Chlorine upon Anhydrous Chloral.—H. Gauttier.—In darkness there is no action, whilst in sunlight the contents of the flask or bottle are completely decolourised in two or three hours.

Moniteur Scientifique, Quesneville.
Vol. xvi., February, 1886.

Notes on the Literature of Explosives (concluded).—Prof. C. Munroe.—From the Chemical News.

Industrial Review.—This includes studies on the utilisation of the slags of the Thomas process; on the fixation of aniline colours by means of antimonious salts; and new methods of mordanting with chrome, and applying gallo cyanine in dyeing and printing.—All from the *Chemiker Zeitung*.

Chemical Patents taken Abroad.—We have here notices of Schroeter's patent for the preparation of ichthyol-sulphonic acid; Müller's process for preparing a firm grease, specially destined for lubricating machinery; Fahlberg and List's patent for obtaining ortho-sulphamine benzoic anhydride, called also "saccharine"; E. H. and A. H. Cowles' improvements in the reduction of ores and the preparation of alloys by the aid of electricity; process of preparing tin oxide and tin-crystals electrolytically, by

R. Tamine and E. de Cuyper; G. Link's process for purifying crude naphthaline by means of soaps; and Dahl's process for the preparation of sulphuretted naphthols and of azo colouring-matters.

The Fatty Matter and the Wax contained in Cinchona-Barks.—O. Hesse.—From Liebig's *Annalen*.

The Process of Tanning with Chrome.—W. J. A. Donald.—From the *Journal of the Society of Chemical Industry*.

Report on the International Exhibition of Inventions at London.—Watson Smith.—From the *Journ. Soc. Chem. Industry*.

Classification of the Colours derived from Coal-Tar.—W. R. Richardson.—From the *Journ. Soc. Dyers and Colourists*.

Summary of the Present State of Knowledge on the Artificial Colours used in the Arts.—Dr. E. Noelting.—The first portion of the first of a course of six lectures delivered at the School of Chemistry at Mulhouse. The matter here inserted extends merely to the history of the principal tar-colours, and to theoretical considerations on the constitution of benzol and its derivatives.

Patents connected with the Chemical Arts taken in France.—A list of titles of patents for November last.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 2, January 15, 1886.

Phosphatic Urine, apparently Albuminous.—P. Carles.—The author refers to the fact that urine which is neutral, or but slightly acid, often gives on heating a coagulum which simulates that produced by albumen. A drop of acetic acid, however, causes this precipitate to disappear, whilst it has no effect upon coagulated albumen. He considers that the spurious precipitate is due to the presence of bibasic phosphates.

The Preparation of Galactose.—E. Bourquelot.—The author effects the process in closed vessels, at a temperature a little above 100°.

Examination of a Liquid of Ascites.—L. Grimbert.—The aspect of the liquid was that of milk. It was neutral to litmus-paper, and this neutrality continued unchanged for more than ten days. During this time no deposit of figured elements occurred, and no trace of fibrine coagulated. It had no odour. On microscopic examination there appeared merely a few fatty globules, very refractive and of small diameter. At 15° its sp. gr. was 1·008. Acetic acid produced no turbidity. Nitric acid and potassium ferrocyanide, mixed with acetic acid, gave very distinctly the reaction of albumenoids. An excess of hydrochloric acid gave in the cold a transparent liquid of a slight violet tint. Glycerin rendered it almost entirely clear.

On a New Method for taking the Fusion and Solidification Points of Neutral Fatty Bodies, and of their Acids.—M. Loviton.—The method consists in recording the magnified phenomena observed on submitting to the microscope a preparation made with the substance in question, and capable, without removal, of being made to vary in temperature at will.

On a Method of Disinfecting Sewer Openings.—E. Monin.—The author uses a disinfectant composed of permanganate or carbon, coal-tar or creosote, and iron sulphate. He remarks that the action of permanganate and of carbon is respectively different, permanganate being an oxidiser and carbon an absorbent or reducer.

The Question of Jequirity and of Jequiritic Ophthalmia.—A medical paper.

The Manna of Turkestan.—M. Markownikoff.—From the *Journal of the Chemical Society*, and the *Journ. Russ. Chem. Soc.*

On Buchu (Barosma crenata).—M. Spica.—From the *Journal of the Chemical Society*.

The Determination of Alkaloids in Extract of Belladonna.—H. Kunz.—Recent leaves of *Belladonna* contain 0·15 to 0·60 per cent of atropine, and the roots 0·30 to 0·60 per cent. The extract contains, according to German analyses, 1·3 to 1·6 per cent of atropine. Le Roy Weber finds 2·57 per cent in an extract according to the American Pharmacopœia. The author finds among the bases choline, which he had previously recognised in the flowers of the elder.

Asbestos Filters.—A. Couvert.—Asbestos paper is now met with in commerce, and is suitable for the filtration of almost all liquids.

The Reductive Action of Coke on Nitric Acid dissolved in Sulphuric Acid in Gay-Lussac's Tower.—G. Lunge.—At the temperature of 38° to 40°, which prevails in the Gay-Lussac towers, this action is very rapid, and the entire nitric acid is transformed into nitrous acid.

Determination of Sulphuric Acid in Vinegar.—B. Kohnstein.—The author saturates 100 c.c. of vinegar with magnesia, filters, and exposes the filtrate to a temperature of 25° to 30°. The organic salts are entirely transformed into carbonates, whilst magnesium sulphate remains unchanged. It is taken up with water saturated with carbonic acid, filtered, and the precipitate is washed. Magnesia is determined in the filtrate, and from it is deduced the quantity of free sulphuric acid contained in the vinegar.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Vol. xii., No. 143, Nov., 1885.

Report presented by M. Biver on behalf of the Committee of Chemical Arts, on M. Kolb's Appliances for raising Corrosive Liquids.—These apparatus, which cannot be explained without the aid of the accompanying diagrams, are divided into two classes, emulsifiers, in which the liquid to be raised is intimately mixed with bubbles of air, compressed or at its natural pressure. The other class includes pulsometers, actuated by compressed air instead of steam.

On Panary Fermentation.—Aimé Girard.—From the *Comptes Rendus*.

On Algin.—Watson Smith.—From the *Journal of the Society of Chemical Industry*.

New Process for detecting and determining Traces of Nitric Acid in Air, Water, Soils, &c.—MM. Grandval and Lajoux.—From the *Comptes Rendus*.

MISCELLANEOUS.

Tonbridge School.—New Science Buildings are now being erected for Tonbridge School, at a cost of nearly £14,000. They will be close to the present buildings, and will contain chemical and physical laboratories, lecture room, class rooms, preparation rooms, and, in addition, a library and room for drawing.

Thermometers for Extreme Temperatures (up to a White Heat).—These instruments, the invention of Messrs. Heisch and Folkard, are specially adapted for all purposes where the temperatures are beyond the range of the ordinary mercurial thermometer, and where an expensive pyrometer has been the only available instrument up to the present time. The reading is taken in exactly the same way as with an ordinary thermometer, the temperature being indicated by the pressure of the air enclosed in a bulb, which is exposed to the source of heat, acting on a vertical column of mercury. By employing a platinum or porcelain bulb the very highest temperatures can be indicated. One of the great advantages of the instru-

ment is that the temperatures are seen at a glance without the time and manipulation required in using the Siemens or other pyrometer. The instrument is, of course, unaffected by changes in the height of the barometer, being hermetically sealed.

The Standard Thermometer, for Chemical and Physical Laboratories, is a convenient form of the simple air thermometer used in physical research. The range of the instrument is from the lowest attainable temperatures up to the softening point of the bulb. The instrument, like the other, is hermetically sealed, and consequently unaffected by barometric variations. It consists of a bulb of platinum or porcelain connected to a glass tube bent back on itself twice, and at right angles to the axis of the bulb; one end of the bent tube is pivoted on the base of the instrument, leaving the other end free to move up and down on a vertical scale, describing an arc round the pivot; the vertical scale is made to move backwards and forwards on a horizontal rod, and can be fixed in any position by means of a set screw. By an easy adjustment, somewhat similar to that of Fortin's barometer, the pressure of the gas enclosed in a bulb exposed to the source of heat is measured in inches or millimetres on the divided scale. From the pressure thus measured the temperature can be at once deduced, either graphically on millimetre paper or by calculation. The pressure of the gas enclosed in the bulb is balanced by a column of mercury contained in the tube, the inclination of which can be varied. The resultant pressures are proportional to the sines of the angles of inclination of the mercurial column to the horizon, after allowing for capillarity; but, as stated above, these pressures are in practice read off on the graduated brass scale. An observation occupies about one minute, the manipulation being as follows:—Level the base plate of the instrument, the bulb being exposed to the temperature to be measured and the mercury tube being horizontal or nearly so. Raise the mercury tube slowly by means of the sliding roller carriage on the brass scale, at the same time moving the scale along the horizontal brass rod as required, and gently tap the mercury tube. The column of mercury will descend in the tube, leaving a vacuum in the upper part. This raising of the tube is to be continued (tapping gently each time) until the top of the mercury is level with a standard mark on the tube. The gas in the bulb is now compressed to a definite volume by the inclined column of mercury, the vertical height of which represents the pressure. To graduate a new bulb or verify an old one, immerse the bulb in melting ice, or in the steam of boiling water, as may be most convenient, and read off on the brass scale the *vertical* height of the column of mercury required to compress the gas to the definite volume (*i.e.*, to the mark on the mercury tube) at 0° or 100° C., as the case may be. For example:—

Vertical height of top of mercurial column at 100° C.	7·53 inches.
Vertical height of bottom of mercurial column at 100° C.	0·58 ,,
Pressure of gas in bulb at 100° C.	6·95 ,,

Suppose now we wish to take the temperature of the vapour of boiling sulphuric acid. Observe the pressure in the same way as before, thus:—

Vertical height of top of mercurial column	11·73 inches.
Vertical height of bottom of mercurial column	0·63 ,,
Pressure of gas in bulb	11·10 ,,

A simple calculation gives the temperature.

6·95 inches pressure = 100° C. What is the temperature at 11·10 inches?

$695x = (1110 \times 375) - (695 \times 375)$.

$\therefore 695x = 416{,}250 - 260{,}625 = 155{,}625 \therefore x = 224°$.

A much simpler plan of deducing the temperature from the pressure is by construction on millimetre paper, for by calculating out two extreme temperatures (the ordinates representing the pressures and the abscissæ the number of degrees) and joining the tops of the two ordinates by a straight line, all the intermediate temperatures can be measured off in the ordinary way.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Compressor Engine.—Can any of your readers inform me what kind of engine would be found most suitable for compressing the acid gases from pyrites kilns, the gases being previously cooled; also the address of makers?—W.

MEETINGS FOR THE WEEK.

MONDAY, 22nd.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Science Teaching," by Prof. F. Guthrie, F.R.S.
TUESDAY, 23rd.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum," by C. T. Newton, C.B.
WEDNESDAY, 24th.—Society of Arts, 8. "The Employment of Autographic Records in Testing Materials," by Prof. W. C. Unwin.
— Geological, 8.
THURSDAY, 25th.—Royal, 4.30.
— London Institution 7.
— Royal Institution, 3. "The Ancient Geography of Britain, by Prof. W. Boyd Dawkins, F.R.S.
— Society of Arts, 8. "Photography and the Spectroscope in their Applications to Chemical Analysis," by Prof. W. N. Hartley, F.R.S.
FRIDAY, 26th.—Royal Institution, 9. "Photography as an Aid to Astronomy," by A. A. Common, F.R.S.
— Quekett Club, 8.
SATURDAY, 27th.—Royal Institution, 3. "The History of Geometry," by Rev. C. Taylor.
— Physical, 3. "Notes on the Thermo-dynamic Relations in the Paper of Messrs. Ramsay and Young," by Prof. W. C. Unwin. "On a Map of the World in which the Proportion of Areas is Preserved," by Walter Baily.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1370.

ANALYSIS OF EMBOLITE FROM ST. ARNAUD, VICTORIA.

By J. M. H. MUNRO, D.Sc., F.C.S.

There do not appear to be many published analyses of this mineral, although according to Mr. Field (quoted by Dr. Percy) much of the reputed silver chloride consists really of chlorobromide. The six analyses given by Dr. Percy ("Metallurgy of Silver and Gold," Part I., p. 217) were all made by Mr. Field, and refer to specimens from one locality—the Chañarcillo Mine, Chile. These analyses agree with one or other of the three formulæ, 2AgCl,AgBr; 3AgCl,2AgBr; AgCl,3AgBr.

Another locality for this mineral is St. Arnaud, Victoria, and an analysis of embolite from this district, by Mr. Charles Wood, is quoted by Brough Smyth in his "Gold Fields of Victoria," p. 411. This analysis shows the embolite from this locality to have a more simple formula than those given above, and agrees exactly with the numbers required for AgCl,AgBr, viz., silver 65·16, bromine 24·16, chlorine 10·71—100·00.

A specimen of mice-eaten ferruginous quartz, dotted over with minute grains of embolite, was brought home from St. Arnaud by my father, Mr. J. M. Munro, and analysed by him. It was obtained above water-level in what is locally known as the "Rotten Reef," and the quartz was so extremely friable and so decomposed, that, although the embolite was abundantly disseminated throughout, it required some hours' patient work with a needle and a lens to detach sufficient of the soft irregular-shaped nodules of mineral for analysis: 5·431 grains of nearly clean mineral obtained in this way were reduced with zinc and sulphuric acid, and the reduced silver dissolved in nitric acid and weighed as chloride, the chlorine and bromine of the mineral being precipitated from the zinc solution by silver nitrate, and weighed together as silver chloride and bromide; 4·563 grains pure silver chloride were obtained, and 5·329 grains mixed silver chloride and bromide. Hence the 5·431 grains mineral contained 0·102 grain gangue, confirmed by an actual weighing of the insoluble residue. From these figures we get the following calculated composition for the pure mineral.

Silver	64·45
Bromine	25·84
Chlorine	9·70
	99·99

These numbers agree substantially with the formula AgCl,AgBr, given by Mr. Wood.

College of Agriculture, Downton, Salisbury.

ON THE RAPID ESTIMATION OF MAGNESIA AS AMMONIO-MAGNESIC PHOSPHATE.

By LAWRENCE BRIANT. F.C.S.

The estimation of magnesia by precipitation with sodic phosphate in the presence of an excess of sodic hydrate is a tedious process, on account of the length of time required to ensure complete precipitation,—variously stated as twelve to twenty-four hours. Experiments were conducted to determine whether the well-known accelerative action of agitation could not be applied to this process, and thereby shorten the duration of the experiment.

The mode of procedure was as follows:—Comparative determinations were made in which the quantity of magnesia in given solutions was estimated by three ways. First, precipitation in the ordinary manner, allowing the liquid to stand in the cold for twenty-four hours; second, after twelve hours; and third, after violently shaking in a stoppered glass jar for ten minutes, at once throwing the liquid on to a filter. The volume of liquid was in each experiment the same, viz. 115 c.c., whilst the precipitate was washed with 100 c.c. of dilute ammonic hydrate (1 to 3), divided into three different washings, between each of which the filter was allowed to drain completely. The precipitate in the case of the experiments in which the liquid was violently shaken was very granular, and was without difficulty completely transferred to the filter.

The results are as follows:—

Treatment.	MgO found.	MgO present.
	Grm.	Grm.
1. Stood 24 hours ..	0·050	0·050
2. Stood 12 hours ..	0·049	0·050
3. Shook 10 minutes..	0·051	0·050
4. Ditto ditto ..	0·050	0·050
5. Ditto ditto ..	0·050	0·050
6. Stood 24 hours ..	0·022	0·022
7. Stood 12 hours ..	0·022	0·022
8. Shook 10 minutes..	0·021	0·022
9. Ditto ditto ..	0·020	0·022
10. Stood 24 hours ..	0·002	0·002
11. Stood 12 hours ..	0·003	0·002
12. Shook 10 minutes..	0·002	0·002
13. Ditto ditto ..	0·0017	0·0015

These experiments seem to prove that whilst the method recommended vastly shortens the length of time occupied in making a determination of magnesia, it in no wise impairs its accuracy.

NOTE ON SO-CALLED "PANCLASTITE."

By H. SPRENGEL, Dr. phil., F.R.S.

In "Notice sur la Panclastite, &c., '*par*' Eugène Turpin, Paris, E. Bernard and Cie., 1882," we read:—

P. 11.—"Panclastite. (Brise tout;—de: παν, tout; κλαω, je brise.) *Explosifs à base de peroxyde d'azote.*

"Principe découvert par Eug. Turpin (1878 à 1882).

"Le corps comburant est le peroxyde d'azote pur et anhydre à l'état liquide.

"Cette section a cela de tout à fait remarquable, c'est qu'aucun des produits qui entrent dans la composition des nombreux explosifs qui en font partie n'a jamais été employé à la confection d'un autre mélange détonant. Le comburant ou les combustibles n'ont jamais été appliqués, en aucun cas, dans ce but, soit ensemble, soit séparément, tandis que dans les 1re, 2e et 4e sections on retrouve le soufre et le charbon.

"Recherchant de suite toute ce que pouvait lui donner la découverte de ce nouveau principe, M. Turpin est parvenu à produire plus de cent explosifs nouveaux, c'est-à-dire un nombre plus considérable que celui qui comprend tous les explosifs connus antérieurement."

P. 5.—"La *Panclastite* est dans ce dernier cas. Découverte par M. Eugène Turpin, elle constitue une invention de principe qu'il ne faut pas confondre avec une invention reposant sur des principes connus, ce qui est le cas de la dynamite; les inventions de principe sont extrêmement rares et tendent à diminuer encore au fur et à mesure que le progrès se développe, tandis que les inventions d'application ou de perfectionnement augmentent constamment."

On this "invention de principe" Sir Frederick Abel in his Presidential Address at the annual meeting of the Society of Chemical Industry, July 11, 1883 (vol. ii., p. 313), kindly expresses himself thus:—

"Sprengel urged that the facts brought forward by him were susceptible of important application, because powerful explosive cartridges or charges might at any time be rapidly prepared from two ingredients which, kept separately, are non-explosive. The suggestion to deal, in mining or military operations, with highly corrosive and more or less volatile liquids, upon the extensive scale which would be necessary if Sprengel's system were turned to practical account, has not commended itself to those experienced in such matters, but attention has quite recently been directed to the subject by a M. Eugène Turpin, who puts forward as an invention of his own what he calls a new series of explosives, which he has christened 'Panclastite,' but which are actually Sprengel's explosive mixtures. In his memoir of 1873 Sprengel gives a table of the total percentages of oxygen, and the percentages of available oxygen, in a great number of oxidising agents, and the superiority of monohydrate of nitric acid over the majority in the latter respect is there shown. Turpin uses, or says he uses, anhydrous nitrogen peroxide as the oxidising agent in his Panclastite series, together with carbon bisulphide or nitro-products of hydrocarbons. He therefore carries out Sprengel's suggestions, selecting for the purpose an oxidising agent of comparatively costly and inconvenient nature, and certainly not superior in oxidising power to the strongest commercial nitric acid. The publication in France of researches or inventions as original, the results or description of which have long been published in England, is an occurrence to which we are not unaccustomed, and so the performances of Sprengel's offspring, furnished by M. Turpin with an impressive family name, are exhibited at Chatou-Rueil, near Saint-Germain, with much flourish of trumpets, and have recently been officially reported upon by a Royal Engineer officer as marvels of novelty and of explosive power."

Though it may appear to be somewhat late to refer at this time to the foregoing comments on my paper in the *Journal of the Chemical Society* of August, 1873, I hope that the importance which this matter promises to attain will excuse and justify the following Note:—

The "beau idéal" of a detonating explosive is a mixture of 8 parts (88·9 per cent) of liquid oxygen and 1 part (11·1 per cent) of liquid hydrogen.

In my paper of 1873 I say, page 799:—"On referring to the foregoing table the reader will be reminded that peroxide of hydrogen is the highest oxygen compound known, while nitric anhydride is the compound which contains the largest amount of oxygen available for combustion (74 per cent). But as this compound, as well as the next two, nitric peroxide (69·5 per cent oxygen) and tetranitromethane (65·3 per cent oxygen) are: at present: on account of their nature and their difficult preparation, mere chemical curiosities, my attention naturally turned to the fourth, to *nitric acid* (63·5 per cent oxygen), which is a cheap and common article of commerce."

Now, when Mr. Turpin's attention turned to the second oxidiser on my list—to nitric peroxide—he found that this substance does *not corrode* metals, such as iron, copper, and tin under 356° F. (180° C.); and further, that combustible liquids, such as petroleum, carbon bisulphide, and nitro-benzene are readily soluble in nitric peroxide *without* rise of temperature. These are valuable properties, *first noticed by Mr. Turpin.*

What was formerly a chemical curiosity, is now an article of commerce. Nitric peroxide may be bought today at eighteen pence the pound, and I see ways and means of producing it a great deal more cheaply. Nitric peroxide is a yellowish liquid, heavier than water (sp. gr. = 1·451) and boils at 71° F. (22° C.), but may be kept like ether or similar volatile liquids. In France it is sent about in tinned-iron cans.

Taking as a typical example a benzene-mixture

$$C_6H_6 = 18{\cdot}4 = \left.\begin{matrix}17{\cdot}0\ C\\ 1{\cdot}4\ H\end{matrix}\right\} = \begin{matrix}62{\cdot}6\ CO_2\\ 12{\cdot}6\ H_2O\end{matrix}$$

$$7\tfrac{1}{2}(NO_2) = \frac{81{\cdot}6}{100{\cdot}0} = \left.\begin{matrix}56{\cdot}8\ O\\ 24{\cdot}8\ N\end{matrix}\right\}$$

we see, that the 18·4 parts of benzene require 56·8 parts of oxygen for the oxidation of their carbon and hydrogen to carbonic acid and water. This oxidation or combustion takes place at the moment of explosion at the expense of the 56·8 parts of oxygen, contained in the rest of the mixture—the 81·6 parts of nitric peroxide. No other explosive now in use (including blasting gelatin) contains weight for weight a greater amount of combustible matter, and as an explosion of *these* bodies is simply a sudden combustion, I again beg to draw attention to the fact, that the oxygen available for combustion in gun-cotton is most probably not more than 32·3 per cent and in nitroglycerin 42·3 per cent,* while in this case we have without a doubt 56·8 per cent. Hence no other explosive now in use can rival this and similar mixtures in power, as I published in 1873. They still remain *the most powerful* explosives known.

It hardly need be said, that an explosive of this nature consists of two parts—an oxidising and a combustible agent—and that Mr. Turpin with the same naïveté lays claim not only to the first but also to the latter half of the subject.

None of my *safety*-explosives are licensed in England, though many of them, when mixed, are much less sensitive to concussion than common gunpowder.

In April 1884 the French military authorities were busy near Rochefort with shells of the "système Turpin." These shells, so my informant said, were made of such a size and possessed such a prodigious power, that a ship struck by one of them would inevitably be sent to the bottom of the sea, even were she the strongest ironclad afloat. It is devoutly to be hoped that those whose office it is to provide for the defence of the British Navy *will be ready* in the hour of need to serve out shells, filled with an explosive of equal force or better still with something superior, approaching more closely the "beau idéal."

CONTRIBUTIONS TO THE KNOWLEDGE OF SAMARIUM.†

By P. T. CLEVE.

(Concluded from p. 93).

Chromate of Samarium and Potassium, $SmK_2CrO_4 + 3H_2O$.

A SOLUTION of bichromate of potassium is not precipitated by nitrate of samarium, but a solution of the neutral chromate is. A bulky yellow precipitate is thrown down, which soon settles down as a crystalline powder of the double salt. As it is decomposed by washing with water it was taken from the filter and freed from the solution by pressure only. The salt of samarium was in excess.

1·6367 grm. lost by 100° 0·0880 grm., and on heating nearly to redness a further loss of 0·0165 grm., or in all 0·1045 grm. H_2O. On dissolving in nitric acid and

* Of these, by the by, only 38·8 per cent can be utilised for want of fuel, as pointed out by me in my patent of 1871 and verified four years later by the force of Nobel's blasting gelatin, in which the excess of 3·52 per cent oxygen is utilised by the dissolved gun-cotton, an explosive too rich in carbon. See: Abbot's table, p. 17, in "The Hell-Gate Explosion near New York and so-called 'Rackarock,' with a few words on so-called 'Panc astite,'" by H. Sprengel. London: E. and F. N. Spon, 1886.

† Presented to the Royal Society of Sciences of Upsala, Feb. 13, 1885.

precipitating with mercurous nitrate a precipitate was obtained which yielded on ignition 0·5387 grm. Cr_2O_3. From the filtrate, freed by H_2S from mercury, 0·6415 grm. Sm_2O_3 was thrown down with ammonia. The filtrate from the samarium hydroxide gave 0·3335 grm. K_2SO_4.

In per cent—

		Calculated.	
Sm_2O_3	39·19	348·0	38·74
K_2O..	11·02	94·2	10·49
CrO_3	43·31	402·0	44·76
H_2O..	6·38	54·0	6·01
	99·90	898·2	100·00

Formiate of Samarium, Sm_3CHO_2.

By saturating boiling dilute formic acid with oxide of samarium a white heavy crystalline powder, very slightly soluble in water, is produced.

0·4062 grm. gave on evaporation with dilute sulphuric acid 0·4206 grm. Sm_23SO_4.

In per cent—

		Calculated.	
Sm_2O_3	61·28	174	61·05
$C_2H_2O_3$	(38·72)	111	38·95
	100·00	285	100·00

Specific gravity—

1·1551 grm., temp. 20°, sp. gr. 3·737
0·6168 „ „ „ 3·730
0·7878 „ „ „ 3·732

Mean, 3·733.
Molecular volume, 76·35.

Acetate of Samarium, $Sm_3C_2H_3O_2 + 4H_2O$.

This salt crystallises at ordinary temperature on spontaneous evaporation in short prisms or tabular crystals which are moderately soluble in water. On evaporating the concentrated solution on the water-bath needle-shaped crystals containing less water are obtained, but the exact quantity of the water of crystallisation in the salt could not be determined, as the salt very rapidly takes up water from the mother-liquor.

The salt crystallised at the ordinary temperature gave on analysis:—

0·7886 grm. lost at 110° 0·1393 grm. H_2O and gave by ignition 0·3444 grm. Sm_2O_3.

0·8688 grm. lost 0·1546 grm. H_2O and gave 0·3802 grm. Sm_2O_3.

In per cent—

			Calculated.	
Sm_2O_3	43·67	43·76	174	43·61
$C_4H_6O_3$	—	—	153	—
H_2O	17·66	17 79	72	18·05
			399	

Specific gravity—

Crystallised salt—

1·1916 grm. small crystals, temp. 15·5°, sp. gr. 1·938
1·1536 „ „ „ 14·5° „ 1·942

Mean of both determinations, 1·940.
Molecular volume, 205·7.

Anhydrous salt—

1·1475 grm., temp. 18·3°, sp. gr. 2·208
Molecular volume, 148·1.

Propionate of Samarium, $Sm_3C_3H_5O_2 + 3H_2O$.

This salt crystallises in small topaz-yellow rhombic tablets tolerably soluble in water. It loses all its water of crystallisation at 100°.

0·6724 grm. lost at 100° 0·0855 grm. H_2O and gave by ignition 0·2797 grm. Sm_2O_3.

1·5953 grm. lost at 100° 0·2023 grm.

In per cent—

			Calculated.	
Sm_2O_3	41·60	—	174	41·11
$C_6H_{10}O_3$	—	—	195	—
H_2O	12·72	12·74	54	12·76
			423	

Specific gravity—

1·0454 grm. crystals, temp. 13·2°, sp. gr. 1·786
0·6051 „ „ „ „ 1·784
0·9918 „ „ „ „ 1·788

Mean of the three determinations, 1·786.
Molecular volume, 237.

Anhydrous salt—

1·3141 grm., temp. 14° . . . . . sp. gr. 1·894

Molecular volume, 194·8.

Ethylsulphate of Samarium, $Sm_3C_2H_5,SO_4 + 9H_2O$.

The solution obtained by double decomposition of the sulphate of samarium with ethylsulphate of barium deposits, on evaporating it slowly over oil of vitriol, large pale yellow and well-formed crystals which are easily soluble in water. Heated to 100° to 110° the salt is decomposed. The loss, 34 per cent, corresponds to 3 mols. C_2H_5OH and $5H_2O$ (33·2 per cent).

0·4253 grm. gave 0·1809 grm. Sm_23SO_4.

In per cent—

		Calculated.	
Sm_2O_3	25·17	174	25·33
$(C_2H_5SO_3)_2O$	—	351	—
H_2O	—	162	—
		687	

Specific gravity—

0·7973 grm. large crystals, temp. 20·8°, sp. gr. 1·894
0·6180 „ „ „ „ 1·885

Mean of both determinations, 1·879.
Molecular volume, 365·6.

Oxalate of Samarium, $Sm_23C_2O_4 + 10H_2O$.

On adding a solution of oxalic acid to solutions of the salts of samarium bulky white and gaseous precipitates are thrown down which soon become heavy and crystalline. Oxalate of samarium is soluble in concentrated nitric acid. At 110° it loses $6H_2O$.

1·0029 grm. gave by ignition 0·4638 grm. Sm_2O_3.

In per cent, 46·25 Sm_2O_3; calc. 46·77.

Oxalate of Samarium and Potassium, $KSm2C_2O_4 + 2(\frac{1}{2}?)H_2O$.

A solution of the nitrate of samarium gave with an excess of neutral oxalate of potassium a white amorphous precipitate. Only a very small quantity remained in the solution. The salt was simply pressed between filter-paper and then analysed.

0·7401 grm. lost 0·0721 grm. H_2O at 125° and at 190° an additional 0·0085 grm., or total 0·0806 grm. H_2O. From the same quantity 0·3063 grm. Sm_2O_3 and 0·1345 grm. KCl were obtained.

In per cent—

		Calculated.	
Sm_2O_3	41·39	174·0	42·43
K_2O..	11·47	47·1	11·48
C_2O_3	—	144·0	—
H_2O..	10·89	45·0	10·97
		410·1	

It is to be assumed that a part of the water found consisted of only hygroscopic moisture, so that the amount of water given in the above formula must not by any means be regarded as exact.

Succinate of Samarium,

$Sm_2C_2H_4(CO_2)_2 + 5H_2O$ (at 100° dried $3H_2O$).

On adding a solution of succinic acid to a solution of the acetate of samarium no precipitate is formed at the ordinary temperature, but, on warming, a copious white micro-crystalline powder is thrown down. The succinate is very sparingly soluble in water. It is decomposed on heating, and leaves a very voluminous oxide of samarium. The salt loses at 100° 5·87 per cent, corresponding to 2 mols. H_2O (calc. 4·88).

0·4333 grm. salt, dried at 100° gave on ignition 0·2161 grm. Sm_2O_3.

In per cent, 49·87 Sm_2O_3. Calculated from the formula with $3H_2O$: 49·57.

Tartrate of Samarium,

$Sm_2C_2H_2(OH_2)_2 + 6$ (dried at 100° 2) H_2O.

A solution of tartaric acid gives with acetate of samarium a white bulky precipitate, which, on warming, changes into a heavy granular non-crystalline powder. Very little samarium remains in the solution. The tartrate, when recently prepared, is soluble in caustic ammonia, but the solution deposits after some time, or immediately on boiling, a white powder. The salt pressed between filter-paper lost at 100° 8·67 per cent H_2O or 4 mols. (calc. 8·45).

0·4602 grm. salt dried at 100° gave on ignition 0·2067 grm. Sm_2O_3.

In per cent, 44·92 Sm_2O_3, and the formula with $2H_2O$ requires 44 61 per cent Sm_2O_3.

Citrate of Samarium,

$SmC_3H_4(OH)(CO_2)_3 + 6$ (at 100° dried 1) H_2O.

Citric acid gives with acetate of samarium a white, bulky, not crystalline precipitate. The salt is soluble in ammonia, and the solution remains clear on boiling.

The salt pressed between filter-paper lost on heating to 100° 21·48 per cent water, corresponding to 5 mols. H_2O (calc 20·13).

0·3828 grm. salt, dried at 100°, gave by ignition 0·1877 grm. Sm_2O_3.

In per cent, 49·03. The formula with $1H_2O$ requires 48·74 per cent.

Picrate of Samarium, $Sm_3C_6H_2(NO_2)_3O + 8H_2O$.

A solution of picric acid dissolves the oxide of samarium on boiling. The intensely yellow solution yields after concentration a heavy orange-coloured oil, which on further evaporation over oil of vitriol dissolves. Later on the salt crystallises in small yellow needles, which are easily soluble and melt below 100°. When strongly heated the salt explodes. The salt loses at 100° 11·83 per cent H_2O, or 6 mols. H_2O, calc. 11·04.

0·7312 grm. of the crystallised salt was dissolved in water and precipitated with an alcoholic solution of oxalic acid. On ignition 0·1308 grm. Sm_2O_3 was obtained.

In per cent, 17·89 Sm_2O_3, calc. 17·79.

Specific gravity—

0·6538 grm., temp. 18°.5, sp. gr. 1·954.

Destructive Distillation of Coal-Tar.—Professor Mills has enlarged and revised his "manualette" of the Destructive Distillation of Coal-Tar, Petroleum, Rosin, Oil, &c., and the new edition, with some illustrations of shale retorts, will be published next month by Mr. Van Voorst.

THIRD REPORT OF THE COMMITTEE*

RE-APPOINTED FOR THE PURPOSE OF DRAWING UP A STATEMENT OF THE

VARIETIES OF CHEMICAL NAMES WHICH HAVE COME INTO USE,

FOR INDICATING THE CAUSES WHICH HAVE LED TO THEIR ADOPTION, AND FOR CONSIDERING WHAT CAN BE DONE TO BRING ABOUT SOME CONVERGENCE OF THE VIEWS ON CHEMICAL NOMENCLATURE OBTAINING AMONG ENGLISH AND FOREIGN CHEMISTS.†

An account of the authorship of some of the various systems of nomenclature which have been devised for the purpose of distinguishing between compounds formed by the union of the same elements in different proportions, has been given in the "Historical Notes" prefixed to the Second Report of this Committee. Among these systems the use of the terminations *ous* and *ic*, to denote respectively lower or higher degrees of saturation of one element or group with another element or group, is perhaps that which has met with the widest acceptance. This system further directs that when electro-negative groups, the names of which ends in *ous* and *ic*, unite with electro-positive groups to form salts, these terminations are to be changed into *ite* and *ate* respectively.

Before proceeding to discuss the practical application of this system, it may be well to point out, as a minor etymological detail, that the literal meaning of the terminations *ous* and *ic* has altered since they were first employed. Thus *ous* (Latin *osus*) ought to denote, on the part of the compound, *richness in* that element to the name of which the termination is attached. For example, *cuprous* (*cuprosus*) means "rich in copper": *cuprous* oxide is primarily an oxide which is *richer in copper* than *cupric* oxide, and only by implication an oxide which is *poorer in oxygen*. This implied signification is, however, that in which the name *cuprous oxide* is nowadays employed. A curious result of this change of literal meaning is to be found in the use of the prefix *hypo* to denote a still lower degree of saturation than that expressed by *ous*. Thus the name *hyponitrous acid* is taken to denote an acid containing still less oxygen than nitrous acid; whereas *hyponitrous* really means "less rich in nitrogen," which is the very opposite. Had the etymology been logically carried out, the prefix ought to have been *hyper*. A similar confusion of ideas is displayed in the use of the prefixes *hyper* and *per* at the other end of the scale; in place of these, *hypo* ought to have been employed. *Perchromic acid* does not, as its name literally taken signifies, contain more chromium than *chromic acid*: it contains less, and ought consequently to have been termed *hypo*-chromic acid.

It need hardly be said that it would be ill-advised to attempt to change a system so firmly established as that involved in the present use of these prefixes *hypo* and *hyper*; and in the above remarks on the etymology of the subject, nothing of the kind is intended. No ambiguity can arise from the use of terms about the meaning of which everyone is agreed, and their mere etymological accuracy is, in view of this all-important consideration, of secondary importance.

The appended list (see next column) will show the application of the *ic* and *ous* nomenclature to salts and salifiable oxides.

Names corresponding with *platinous* and *platinic* would be applied to the corresponding oxides and salts of the other metals of the platinum group—distinguishing, however, the other oxides and salts of this group by numeral or other designations.

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* Consisting of Professors Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary), and V. H. Veley.

† Read at the British Association, Aberdeen Meeting, Section B.

I. *List of Salts where Two or more Series of Compounds are formed.**

Name denoting metallic radical of salt.	Formula of corresponding oxide.	Name denoting metallic radical of salt.	Formula of corresponding oxide.
Cuprous	Cu_2O	Chromous	CrO
Cupric	CuO	Chromic	Cr_2O_3
Mercurous	Hg_2O	Uranous	UO_2
Mercuric	HgO	Uranic (Uranylic)	UO_3
Aurous	Au_2O	Manganous	MnO
Auric	Au_2O_3	Manganic	Mn_2O_3
Thallous	Tl_2O	Ferrous	FeO
Thallic	Tl_2O_3	Ferric	Fe_2O_3
Stannous	SnO	Cobaltous	CoO
Stannic	SnO_2	Cobaltic	Co_2O_3
Cerous	Ce_2O_3	Platinous	PtO
Ceric	CeO_2	Platinic	PtO_2

The designations given in this Table to the various higher and lower series of salts and salifiable oxides have been employed with almost complete uniformity by all chemists who have adopted this system of nomenclature.

As a metal rarely—if ever—forms more than two salifiable oxides, the *ous* and *ic* terminations generally suffice for purposes of distinction so far as the salts of metals are concerned.

The practice of further employing these terminations in the case of acid-forming oxides does not lead to confusion, since these oxides are distinguished by the name *anhydride* (or *acid*). Thus we have—

CrO	Cr_2O_3	CrO_3
Chromous oxide.	Chromic oxide.	Chromic anhydride. (Chromic acid.)

Indifferent oxides have frequently been classified and named by regarding them as compounds of salifiable, with acid-forming oxides, Cr_2O_4 being termed *chromic chromate*. For stages lower than *ous*, the prefixes *hypo* and *sub* are employed. Custom appears to have restricted *hypo* chiefly to acids and to acid-forming oxides, *sub* to salifiable and to indifferent oxides.

With regard to the termination *ous*, the minor question arises, how far this termination ought to be written in the forms *ious* and *eous*. The answer is: as seldom as possible. "Cupreous" has generally given way to "cuprous"; no one writes "chromious" (although the name of the metal is "chromium"): and there is no reason why such names as "ruthenious" and "iridious" should not equally be shorn of their superfluous penultimate syllable.

A further question; concerning which considerable difference of opinion has prevailed, is whether any *ous* or *ic* terminations ought to be employed in the names of salts of which only one class is known—thus *magnesic sulphate* instead of *magnesium sulphate*. There is something to be said here for both systems; and, as the diversity of practice does not lead to confusion and consequently does but little harm (beyond in each case offending the ears of those accustomed to the opposite system), the question need not be regarded as a vital one. Objections which have been urged against the use of any termination in such cases are that chemists have not always been able to agree as to which termination is to be used in a given case, and that, apart from this, the practice causes beginners erroneously to surmise the existence of a second series of salts. The objection on the other side is that the omission of the terminal "ic" breaks the uniformity of the system and leads beginners to suppose that barium sulphate, for instance, has a different constitution from cupric sulphate. In the case of carbon compounds, on the other hand, there is a distinct advantage in affixing *ic* to the names of the positive radicals in ethereal salts. A neglect of this precaution leads to ambiguity—at all events in the *spoken* name. Thus, though there is no ambiguity in the name *ethyl phenylacetate* when written, yet the ear cannot distinguish between it and *ethylphenyl acetate*. This ambiguity is obviated by the use of the termination *ic*; thus, *ethylic phenylacetate* and *ethylphenylic acetate*.

In the use of the terminations *ous* and *ic* to distinguish different series of *acids and acid-forming oxides*, the practice of chemists has also been very uniform. Indeed, with the exception of one or two isolated cases almost perfect unanimity has prevailed.

To sum up, the *ous* and *ic* terminations when employed for purposes of distinction in cases where two series of oxides, acids salts, &c., are known, have been almost free from ambiguity, and for this reason deserve to be retained. On the other hand, in cases where only one series is known, those chemists who have employed one or other of these terminations have occasionally differed as to which ought to be used: the difficulty may be solved, as it has been done by some chemists, by avoiding the use of any termination in such cases.

In complex cases where the above modes of naming prove inadequate, recourse may be had to numeral designations. These appear especially admissible in cases where an oxide occurs which is intermediate between the *ous* and *ic* stage, and at the same time cannot be classed as a compound of oxides already classified and named.

In applying numeral designations it is most important to select only such as are free from hypothesis, and which afford correct information. In this respect chemists appear not to have been sufficiently careful of late years. As an example *arsenious oxide* may be quoted: this compound is frequently termed "arsenic trioxide," the formula being written As_2O_3, and it is tacitly assumed that the molecule contains three oxygen atoms. There are three objections to this name:—(1) That, assuming the formula on which it is based to be correct, it affords no information as to the number of *arsenic* atoms associated with the *three* oxygen atoms; (2) that it involves the assumption that arsenious oxide does not vary in molecular weight, whatever its physical state; and (3) that the formula of *gaseous* arsenious oxide is As_4O_6.

In employing numeral designations to indicate molecular composition in cases where this is established, it is therefore important to express the number of atoms of each constituent element, as *dicarbon hexachloride*, C_2Cl_6. But in the case of solid and liquid bodies of which the molecular weight is unknown, or which may vary with temperature, the name should merely indicate the relative proportions in which the constituents are associated; or, more explicitly, the name should indicate the proportion of the radical associated with what may be termed the characteristic element of the compound. No difficulty occurs in the case of the chloride, or analogous compound, of the monad elements generally, these being termed mono-, di-, tri-, tetra-, penta-, or hexa-chloride, &c., according as combination is in the proportion of 1, 2, 3, 4, 5, or 6 atoms of chlorine to 1 atom of the characteristic element. The application of this system would involve the use of the names tin dichloride and iron trichloride (not sesquichloride) for stannous and ferric chlorides respectively, names which accurately express the relative proportions of metal and of chlorine in these compounds without any hypothesis as to their molecular composition, which in the case of the former compound, at all events, certainly depends on temperature. It will, however, involve a slight departure from the existing practice when applied to oxides, sulphides, and other compounds of polyad elements; thus oxides of the type $(R_2)^{vi}O$ would be termed *hemi*-oxides, since they consist of the characteristic element and oxygen in the proportion of *one* atom of the former to *half* an atom of the latter. Oxides of the type $(R_2)^{vi}O_3$ would be termed *sesqui*-oxides, since the characteristic element and oxygen are present in the proportion of *one* of the former to *one and a half* of the

* In this list the term "salt" is taken to include "haloid salts," but to exclude the halogen compounds of those elements whose oxides do not yield oxy-salts with acids.

latter. Oxides of the type R_2O_5 would be termed *sesterti*-oxides, as they contain oxygen and the characteristic element in the proportion of *two and a half* atoms of the former to *one* of the latter. Oxides of the types RO, RO_2, RO_3, and RO_4 would be termed respectively *mono*-, *di*-, *tri*-, and *tetr*-oxides.

Acid Salts.

There are two distinct classes of salts to which this name has been given:—

1. Salts with two or more metals, one of the metals being hydrogen.
2. Salts formed from these by the removal of water.

Until comparatively lately no attempt was made to give distinctive names to these two classes, except that sometimes the words hydratic and anhydrous were used to distinguish them. The distinctive names—pyrophosphate, metaphosphate—which Graham gave to the two sets of anhydrous acid phosphates were founded on the supposition that the phosphoric acid (PO_5) existed in them in two modifications, different from the acid of the ordinary phosphates.

The nomenclature used by nearly all chemists from the beginning of this century until about 1860 is illustrated on Tables III. to VI. Acid salts in which for the same quantity of base there is two, three, . . . &c., times as much acid as there is in the normal salt are called bi——ate, ter——ate, &c. (in German, doppelt or zweifach ——saures Salz, dreifach——saures Salz, &c.). In English and French the Latin adverbial numerals *bis* or *bi*, *ter*, &c., seem always to have been used until about twenty years ago, when Greek adverbial numerals were introduced for the anhydrous acid salts. "Watts's Dictionary" and Naquet are the first English and French authorities in which we have observed this change.

Basic Salts.

There are two distinct classes of salts to which this name has been given:—

1. Salts with two or more salt radicals, one of the salt radicals being hydroxyl.
2. Salts formed from these by the removal of water.

These were not distinguished by name until quite recently, and are still very often confused.

The nomenclature in general use is illustrated on Tables 8 to 12.

Basic salts of oxygen acids in which for the same quantity of base there is ½, ⅓, &c., as much acid as there is in the normal salt are called di——ate, tri (or tris)——ate, &c. (in German, halb——saures Salz, drittel——saures Salz, &c.).

Basic salts of oxygen acid were also named by the proportion of base to acid, the proportion in the normal salt being taken as unity—bibasic, terbasic, &c., salts (in German. zweifach, dreifach, &c., basische Salze). Thus *tris*nitrate (drittel saures salpetersaures Salz) is the same as *ter*basic nitrate (dreifach basisches salpeter saures Salz), Latin adverbial numerals being used for multiples, and Greek adverbial numerals for submultiples.

The compounds of basic oxides with haloïd salts (corresponding to the basic salts of the oxygen acids) are variously named: thus, oxychloride, bisoxychloride, basic chloride, bibasic chloride. The numerals here refer not to the number of atoms of oxygen and halogen, but to the proportion of metal combined with oxygen and halogen respectively (or perhaps more correctly to the proportion of *equivalents* of oxygen and halogen): thus $2PbO.PbCl_2$ is bisoxychloride, or bibasic chloride. It is to be noted that corresponding basic haloïd and oxygen salts have not the same numeral; as—

$PbO.PbCl_2$ is basic chloride (einfach basisches Chlorid).

$PbO.Pb(NO_3)_2$ is bibasic nitrate (zweifach basisches Salz), because it is $2PbO.N_2O_5$.

$2PbO.PbCl_2$ is bibasic chloride (zweifach basisches Chlorid).

$2PbO.Pb(NO_3)_2$ is terbasic nitrate (dreifach basisches Salz), because it is $3PbO.N_2O_5$.

Sulphur Salts.—(Table 14.)

These have sometimes, especially in German, been named as double sulphides, but usually, in Latin, English, French, and recently also in German, follow the names of the corresponding oxygen salts.

Sulphur Basic Salts.—(Table 13.)

Compounds of normal salts with sulphides of the metal. These were discovered by H. Rose, and called by Berzelius sulphur basic (schwefel basisch), as corresponding to the compounds of normal salts with the basic oxide. This nomenclature has not been generally adopted, and, and, as will be seen from the table, there is little uniformity in naming these substances.

Double Salts.

With very few exceptions, these may be classified in two sets. 1. With a common salt radical. 2. With a common metal. 1. With a common salt radical. Here again there are two kinds. (*a*) Salts of polybasic acids. (*b*) Compounds of two haloïd salts, or of a haloïd salt, with a compound of a halogen and a non-metallic element.

(*a*) These are named consistently with the names of the simple salts; as phosphate of magnesia and ammonia, phosphorsaure ammoniakmagnesia, magnesium ammonium orthophosphate, ammonic magnesic phosphate, or, with what may perhaps be called an adverbial modification of the first adjective, ammonio-magnesic phosphate.

(*b*) Of these we may take as examples $2KF, SiF_4$; $2KCl, PtCl_4$; 2KCN, $Pt(CN)2$; KF, BF_3; $KCl, AuCl_3$;

No.	Author.	Edition.	Date.
1.	Thomson	II.	1804
2.	Thomson	IV.	1810
3.	Thomson	V.	1817
4.	Brande	I.	1819
5.	Thomson	VII.	1831
6.	Brande	IV.	1837
7.	Ongren (Table to Berzelius)	IV.	1838
8.	Brande	V.	1841
9.	Graham	I.	1842
10.	Gmelin	IV.	1843—4
11.	Liebig (Geiger)	V.	1843
12.	Mitscherlich	IV.	1844
13.	Handwörterbuch	I. & II.	1848—64
14.	Kopp's Geschichte (vol. iv.)	—	1847
15.	Kane	II.	1849
16.	Graham	II.	1850 & 1858
17.	Regnault	III.	1851
18.	Fownes	V.	1854
19.	Otto	III.	1855—60
20.	Miller	I.	1856
21.	Regnault	V.	1859
22.	Rose (French)	—	1862
23.	Watts's Dictionary and Supplements	—	1863—81
24.	Naquet	II.	1867
25.	Rose (Finkener)	VI.	1867—71
26.	Fownes	X.	1868
27.	Williamson	II.	1868
28.	Wurtz's Dictionary	—	1869—76
29.	Bloxam	II.	1872
30.	Regnault Strecker-Wislicenus	IX.	1877
31.	Kolbe, Kurzes Lehrbuch ..	—	1877—8
32.	Fownes	XII.	1877
33.	Miller	VI.	1878
34.	Roscoe and Schorlemmer ..	—	1878—81
35.	Frankland and Japp	—	1884
36.	Kolbe (Humpidge)	—	1884

4KCN, $Fe(CN)_2$; 3(KCN),$\frac{1}{3}Fe(CN)_3$. See Tables 15, 16, 17.

These have been named on three different principles:—

(α) As double fluorides, chlorides, &c.; for instance, fluoride of silicon and potassium, fluorkieselkalium.

(β) As compounds of the positive metal with a compound salt radical; for instance, ferrocyanide of potassium, silicofluoride of potassium, kieselfluorkalium.

(λ) As analogues of oxygen salts; for instance, fluosilicate of potassium, potassium fluosilicate, potassium chlorplatinate, chloraurate, cyanaurate.

The third system seems only to be used when there is really a corresponding oxygen compound.

2. With a common metal. As a well-known substance mentioned by most systematic writers, emerald green has been selected—Table 18. It will be seen that where a name is given, it is either acetate and arsenite, or a combined name, acetoarsenite, or arsenigessigsaures Salz.

I.

1. Muriat of lime.
2. Muriate of lime.
3. Chloride of calcium (also muriate of lime).
4. Chloride of calcium.
5. Chloride of calcium.
6. Chloride of calcium (cal + C).
7. Chloretum calcicum (CaCl).
8. Chloride of calcium or muriate of lime (Cal + C).
9. Chloride of calcium (CaCl).
10. Chlorcalcium (CaCl).
11. Chlorcalcium (calcium chloratum) ($CaCl_2$).
12. Chlorcalcium (CaCl).
13. Calciumchlorid, chlorcalcium (Salzsaurer Kalk) (CaCl), 1859.
14. Chlorcalcium.
15. Chloride of calcium (CaCl+6 Aq).
16. Chloride of calcium (CaCl).
17. Chlorure de calcium (CaCl).
18. Chloride of calcium (CaCl).
19. Chlorcalcium (CaCl).
20. Chloride of calcium.
21. Chlorure de calcium (CaCl).
22. —
23. Chloride of calcium ($CaCl_2$). 2nd Supp. Calcium chloride.
24. Chlorure de calcium.
25. Chlorcalcium.
26. Calcium chloride ($CaCl_2$).
27. Calcic chloride (Cl_2Ca).
28. Chlorure de calcium.
29. Chloride of calcium ($CaCl_2$).
30. Chlorcalcium ($CaCl_2$).
31. Chlorcalcium ($Ca''Cl_2$).
32. Calcium chloride ($CaCl_2$).
33. Calcic chloride (or chloride of calcium) ($CaCl_2$).
34. Calcium chloride (chloride of calcium ($CaCl_2$).
35. Calcic chloride ($CaCl_2$).
36. Calcium chloride ($CaCl_2$).

II.

1. Sulphat of soda.
2. Sulphate of soda.
3. Sulphate of soda.
4. Sulphate of soda.
5. Sulphate of soda.
6. Sulphate of soda ($\dot{S}+\dot{s}'$).
7. Sulphas natricus ($Na\dot{S}$).
8. —
9. Sulphate of soda (NaO,SO_3+10HO).
10. Einfach schwefelsaures Natron.
11. Schwefelsaures Natron (natrum sulphuricum) ($NaO,SO_3,10Aq$).
12. Schwefelsaures Natron ($Na\dot{S}+10Aq$).
13. Schwefelsaures Natron, neutrales, 1859.
14. Schwefelsaures Natron.
15. Sulphate of soda ($NaO.SO_3+10Aq$).
16. Sulphate of soda (NaO,SO_3).
17. Sulfate de soude (NaO,SO_3).
18. Sulphate of soda (NaO,SO_3).
19. Schwefelsaures Natron (NaO,SO_3).
20. Sulphate of soda (NaO,SO_3).
21. Sulfate de soude ($NaO.SO_3$).
22. —
23. Normal or Neutral sulphate of sodium. 2nd Supp. Sodium sulphate (Na_2SO_4).
24. Sulfate neutre de soude.
25. Schwefelsaures Natron.
26. Sodium sulphate (SO_4Na_2).
27. Sodic sulphate (Na_2SO_4).
28. Sulfate neutre de sodium.
29. Sulphate of soda (Na_2O,SO_3).
30. Neutrales schwefelsaures Natrium, oder Dinatriumsulfat ($Na_2SO_4,10H_2O$).
31. Schwefelsaures Natron, neutrales ($SO_2\begin{matrix}ONa\\ONa\end{matrix}+10H_2O$).
32. Sodium sulphate.
33. Sodic sulphate, or sulphate of sodium (Na_2SO_4).
34. Normal sodium sulphate (also sulphate of soda).
35. Sodic sulphate (SO_2Nao_2).
36. Sodium sulphate.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 18th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

The certificate of Mr. Charles Kilpatrick, Dearnley, near Rochdale, Lancashire, was read for the first time.

The following changes in the Council, proposed by the Council, were announced:—

As Vice-Presidents: Prof. Dewar, F.R.S., and Mr. David Howard, vice Dr. Schunck, F.R.S., and Mr. W. Weldon, F.R.S. (deceased).

As Members of Council: Messrs. J. A. R. Newlands, S. U. Pickering, Prof. Ramsay, and Dr. Stevenson, vice Dr. E. Atkinson, Prof. G. C. Foster, F.R.S., Mr. Ludwig Mond, and Mr. C. O'Sullivan, F.R.S.

Prof. Wyndham Dunstan, Dr. Percy Frankland, and Mr. Makins were appointed by the Meeting to audit the Society's accounts.

The following papers were read:—

14. "*The Constitution of Undecylenic Acid as indicated by its Magnetic Rotation: and on the Magnetic Rotation, &c., of Mono- and Di-allylacetic Acids and Ethylic Diallylmalonate.*" By W. H. Perkin, Ph.D., F.R.S.

When investigating the magnetic rotation of compounds (*Trans.*, 1884, 421) undecylenic acid was amongst those selected for examination as examples of the series of unsaturated monobasic acids having the formula $C_nH_{2n-1}COOH$. The numbers obtained, however, were lower than was expected, and did not appear to be consistent with those given by other members of this series, and were therefore kept back for the purpose of further investigating the apparent discrepancy.

Both the acid and its ethylic salt were examined. The acid, purified by rapid distillation under reduced pressure (b.-p. 230° to 235° at 130 m.m.) gave a molecular rotation of 12·547. The ethylic salt boiled at 263·5° to 265·5° (corr.), and gave a molecular rotation of 14·530.

Comparing these numbers with those of the corresponding saturated compounds, we get—

		Difference due to unsaturated character.
Undecylenic acid	12·547	+ 0·897
Undecylic „	11·650	
Ethylic undecylenate ..	14·530	+ 0·890
„ undecylate	13·640	

On reference to the table given in the author's former paper (*Trans.*, 1884, 561) it will be seen that these differences are much lower than those (1·112) obtained for ethylic α-crotonate and oleate, but very nearly equal to those (0·914) found in the case of allyl substitution-products.

As these numbers were obtained before the author became aware of the influence of the magnetic field on the optical parts of the polarimeter, it was deemed advisable to re-examine the ethylic salt. The molecular rotation then obtained was 14·543, thus making the difference due to saturation 0·903, or almost identically that previously found with unsaturated compounds containing the allyl-group. As this appeared to indicate that undecylenic acid is an allyl compound, it was determined to examine allylacetic acid for the purpose of comparison. This was prepared by heating allylmalonic acid as long as carbonic anhydride was evolved, and fractioning the residue. It boiled at 185° to 188° (corr.), and gave a molecular rotation of 6·426. From this we get almost the same difference as with the undecylenic compounds:—

Allylacetic acid	6·426
Valeric „	5·508
Difference	0·918

It is thus seen that undecylenic acid and its ethylic salt possess magnetic rotations which are peculiar to mono-allyl derivatives of the fatty acids.

The next question is as to the position of the allyl-group, as it is probable that the magnetic rotation would be the same whether it were, for example, an allyl-hexyl-acetic acid or an allyl-octylic acid:—

$C_3H_5 \cdot CH(C_6H_{13}) \cdot COOH$ or $C_3H_5 \cdot C_7H_{14} \cdot COOH$.

But Krafft has shown that when oxidised with nitric acid it yields normal sebacic acid; and there can therefore be scarcely a doubt that undecylenic acid is allyloctylic acid, $CH_2{:}CH \cdot CH_2(CH_2)_7 \cdot COOH$.

Whilst working on this subject it was thought interesting to prepare and examine diallylacetic acid. This was made from diallylmalonic acid, and boiled at 227° to 227·5° (corr.). It gave a molecular rotation of 10·344. The molecular rotation calculated for octylic acid is 8·577. There is thus a difference of 1·767 for the influence of the two allyl-groups. Deducting 0·903 for the first allyl-group, we get 0·864 for the second,—a result consistent with previous results (see former paper), which showed that the influence decreases with successive displacements.

The re-determination of the molecular rotation of ethyl diallylmalonate in a freshly-prepared specimen gave 15·025, or a number differing by only 0·027 from that (14·998) given in the former paper.

15. "*Reactions supposed to yield Nitroxyl or Nitryl Chloride.*" By W. Collingwood Williams, B.Sc.

Direct union of chlorine and nitrogen peroxide does not take place either at a red-heat or at 150° C., nor does the action of chloranhydrides (such as phosphorus oxychloride or sulphuryl chloride) on nitric acid or nitrates yield nitryl chloride.

When chlorine and nitric peroxide are passed through a red-hot tube the product is a mixture of nitric peroxide and nitrosyl chloride containing chlorine in solution, while oxygen gas is liberated. This result is due to the dissociation of NO_2 into $NO + O_2$ at a red-heat.

When the tube is heated to 150° C. only, no appreciable change occurs, the product being a solution of chlorine in the peroxide, and an exactly similar product is yielded by all the other methods examined.

16. "*The Condition of Silicon in Cast-Iron.*" By A. E. Jordan and Thomas Turner.

The authors have endeavoured to ascertain whether crystallised silicon can be separated from cast-iron. They refer to the work of Wöhler, Richter, and others, who believed that they had obtained crystals of silicon, and also to the experiments of Snelus, Morton, and Tilden, who were unable to separate silicon from cast-iron in this form.

1. Several irons, including a specimen of pig containing 9·8 per cent silicon, were submitted to magnetic examination. Though both graphite and slag could be separated by means of the magnet, it was not found possible to separate silicon in this manner.

2. The residue left after prolonged boiling with dilute hydrochloric acid was then studied. After drying, the graphite was burned off in a muffle, and the remainder examined for silicon. In no instance was silicon found; but in the case of a pig with 10·3 per cent silicon, black scales were obtained of very difficultly decomposable iron silicide. These scales appear to closely resemble in properties the so-called graphitic silicon of some other observers. In the residue, before roasting, the authors found a quantity of substance resembling Wöhler's "leucome," the "silicon formanhydride" of Friedel and Ladenburg.

3. Lastly, graphitic matter from iron was examined. For the two specimens used they are indebted to Dr. Percy. The first was graphite from Dowlais, which had previously been examined by Dr. Percy, who suggested that it might contain crystallised silicon (*Iron and Steel*, p. 145). It was found to be nearly pure carbon, and to be almost entirely free from silicon in any form. A specimen of kish, from Clarence Works, Middlesbro', was also examined, but in this case too no crystallised silicon was found.

The authors conclude that silicon is present in cast-iron in the form of silicide, being probably a solidified solution in the excess of iron.

Discussion.

The President remarked that the results now brought forward pointed to the importance of direct synthetic experiments with silicon and iron as a means of ascertaining whether graphitic silicon can separate from iron under any conditions. Since it had been shown that the supposed crystalline modifications of boron were compounds with aluminium and carbon (Hampe, *Annalen*, 1876, 183, 75), even the existence of a graphitic silicon appeared doubtful.

Mr. Turner said, that although he had not been able to make such experiments, he had examined irons containing up to 10 per cent of silicon, and had always found the silicon to be present in the one form.

Sir Frederick Abel desired to express his concurrence in the conclusions arrived at by the authors, that there appeared to be no grounds for considering that silicon might exist in cast-iron in the graphitic or crystalline form, or that this element might occur in two different conditions in cast-iron, as carbon did. The result of very numerous experiments and the careful examination of many graphitic residues obtained from cast-iron, had long since led him to these conclusions, but he hesitated referring to his own special experience of many years back in connection with the chemistry of cast-iron, after the remarks which Professor Unwin was reported to have made on the occasion of Mr. Turner's last paper as to the condition of the chemist's knowledge of cast-iron 30 odd years ago. He had been as much surprised as amused to learn that at about the date when certain questions relating to a supply of iron to Woolwich arose, to which Professor Unwin had referred, the methods of determining carbon were faulty, and no distinction was drawn between graphitic and combined carbon. It was true that

the analytical results given in the Woolwich Report, "Cast-Iron Experiments, 1858," included statements of the proportions of graphite only in the partial analyses of samples then carried out for a special object; but in an Official Report, published two years previously by the War Office, the results of analyses of a number of specimens of cast-iron used in the manufacture of ordnance included the items of "total carbon" and "carbon as graphite." In a paper contained in the Quarterly Journal of this Society for 1857, the proportions of *combined carbon* and of graphite existing in specimens of cast-iron of foreign manufacture were also given by Sir Frederick. As regards the methods of analysis practised in those days, and which had been for some time previously taught at the School of Mines and elsewhere, they were in all essential respects similar to and as trustworthy as those now in use. He had learned with surprise that the eminent engineer who had made those criticisms on the work of 30 years ago, and thought it sufficient for his purpose to refer only to the work of one who certainly was never accepted by chemists as an authority on iron analysis.

As regards the matter of the Nova Scotia iron to which Professor Unwin had referred, and which was dealt with in 1858, not 1853, it was right he should state that a quantity of iron called Nova Scotian, supplied for gun-manufacture, was rejected, *not* "because the Chemical Department refused to sanction its use on the ground that it contained too much silicon," but because, instead of being a grey iron somewhat siliceous but otherwise of high quality, having the characters of charcoal-iron—as was the case with the sample of Nova Scotia iron which led to the purchase of a supply, it consisted in large proportion of white and light mottled iron, some of which contained as much as from 1 to 2 per cent. of phosphorus. Certain experiments were made on the effect of melting selected samples of this supply high in silicon, with the result that the strength of the metal was increased without a very material alteration in the proportion of silicon, but these results had no bearing upon the fitness of even this metal to resist powder-strains, nor upon the question whether the supply should not be rejected. The matter having been submitted to arbitration, Mr. Fairbairn, as umpire, decreed in favour of the rejection. In conclusion he ventured to assure Professor Unwin that, by reference to the literature of that time, he would find that chemists were by no means far behind their brethren of the present day in regard to their knowledge of methods of analysis and properties of cast-iron.

17. "*Certain Aromatic Cyanates and Carbamates.*" By H. Lloyd Snape, B.Sc.

The author finds that on heating phenyl cyanate with pyridine it is converted into *diphenyl dicyanate*, $C_{14}H_{10}N_2O_2$. He has prepared a number of dicyanates by the action of carbonyl chloride on dyamines, and has studied their behaviour with alcohols, as in his previous work on phenyl cyanate (*Chem. Soc. Trans.*, 1885, 770). *Diphenylene diisocyanate*, $CO:N\cdot C_6H_4\cdot C_6H_4\cdot N:CO$, was obtained from benzidine hydrochloride and phosgene; on treatment with alcohol it is converted into *diphenylene diurethane*, $COOEt\cdot NH\cdot C_6H_4\cdot C_6H_4\cdot NH\cdot COOEt$, which may also be prepared from benzidine and ethylic chloroformate; the corresponding phenylated urethane is obtained by the interaction of phenol and diphenylene diisocyanate.

Metatoluylene diamine and phosgene react to form metatoluylen diisocyanate, which is converted by phenol into the carbamate $Me\cdot C_6H_3(NH.COOPh)_2$.

No cyanate was formed on heating orthotoluylenediamine with phosgene; both this diamine and orthophenylenediamine, however, react with ethylic chloroformate to form urethanes.

On heating phenyl hydrazine at 220—230° in an atmosphere of carbonyl chloride, a solid compound of phenyl cyanate with hydrogen chloride was formed.

18. "*The Oil obtained from Lime-Leaves.*" By Francis Watts.

The fragrant yellow oil of the lime-tree (*Citrus limetta*) obtained by distilling the leaves and young shoots in a current of steam, contains a citrene, $C_{10}H_{16}$, boiling at 178—179°, and methylnonyl ketone; it appears also to contain "terpinol." On distillation about one-half boils above 280° and has the appearance of colophene.

At the next meeting, on March 4th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Influence of Temperature on the Heat of Chemical Combination." By S. U. Pickering.

"The Action of Heat on the Salts of Tetrethylphosphonium." By N. Collie.

"A New Method for the Preparation of Tin Tetrethyl." By N. Collie and Professor Letts.

NOTICES OF BOOKS.

Electro-Deposition; a Practical Treatise on the Electrolysis of Gold, Silver, Copper, Nickel, and other Metals and Alloys, with Descriptions of Voltaic Batteries, Magneto and Dynamo-Electric Machines, Thermopiles, and on the Materials and Processes used in every Department of the Art, and several chapters on Electro-Metallurgy. By Alexander Watt. London: Crosby Lockwood and Co.

This book opens with three historical chapters giving an account of the rise and progress of Voltaic electricity—without mention of the anticipation of Galvani's initial experiment by the illustrious Dutch naturalist, Swammerdam—of electro-magnetism, magneto-electricity, dynamo-electricity, and thermo-electricity, which latter Mr. Watt believes has before it a great future, the thermo-pile being the only example of the direct conversion of heat into electric energy, and as far as is known this is generated without any other waste beyond that of the fuel consumed in generating the heat necessary.

The fourth chapter gives from original sources the history of electro-deposition. Our readers will doubtless be surprised to learn that the earliest successful experiments were made by Sir H. Bessemer when a youth of eighteen, anticipating Jacobi by about seven years, and that Jordan was the first to publish a definite process.

In the fifth chapter we find a theory of electrolysis, whilst in the following section there is an examination of electrical theories in their relation to the deposition of metals. The processes for coppering, gilding, and silvering are next expounded with great minuteness.

The electro-deposition of nickel, tin, iron, zinc, and some of the metals less generally used is next considered, followed by instructions for the deposition of alloys, such as brass, bronze, and German silver.

We have then three chapters on electro-metallurgy, under which head rank processes for refining copper and lead; for the electrolytic refining of gold, silver, and copper ores, and for the electro-chlorination of gold ores.

In conclusion follow chapters on some mechanical operations subsidiary to electro-deposition, on the recovery of the precious metals from waste solutions, and on stripping metals from each other.

A separate chapter is devoted to the consideration of the chemical agents used in the electro-plastic art.

Under the heading "Useful Information" Mr. Watt gives hints on the management of batteries, their relative power, intensity, and constancy; tests for free cyanide, and remedies in case of poisoning. Such information is exceedingly valuable to all persons obliged to manipulate so formidable a poison as potassium-cyanide. Accidents from this substance are not unfrequent in electro-plating

works. Indeed, the author confesses to having been three times placed in some danger by swallowing a solution of cyanide, or inhaling its fumes. He recommends that the coldest water procurable should be poured upon the head and allowed to run down the spine of the sufferer, whilst ammonia or bleaching lime is cautiously applied to the nostrils. He even recommends that this acid should never be used without a second person holding a phial of one of these agents near the nose of the operator. We should recommend as a more excellent way to hold the breath entirely whilst pouring out hydrocyanic acid from a bottle, or never to work with it except under a good draught-hood.

Mr. Watt's work will be very serviceable to technical students, to apprentices, workmen who are seeking to qualify themselves for more responsible positions, and, if we may venture to say so, to manufacturers who feel the necessity of discarding rule-of-thumb and combining in future practice with theory.

Sound, Light, and Heat. By ALFONZO GARDINER. Part I., Elementary Stage. Manchester and London: J. Heywood.

THAT this manual meets a want of the present day is at once apparent seeing that it has reached its fourteenth edition. The examinational character of the work is most pronounced, as it will be seen not merely from the prefaces to successive editions, but from numerous foot-notes which seem designed to meet a possible question. We are compelled to call attention to a significant passage in the preface to the thirteenth edition, premising that we by no means blame Mr. Gardiner, but the vicious system to which he and numbers of other competent and doubtless conscientious teachers are compelled to conform. Says the author, "The curse of the present day, as regards examinations, is the studying of brief outlines, and trusting to them *alone* as being sufficient for the purposes. (What purposes?) The result is that cram takes the place of that thorough knowledge which enables a student to 'tackle' a question when it is presented in an unusual form, and out of the abundance of his knowledge to show an examiner that, if he has not learnt everything, he has at least learnt something, and knows that something well."

So the purpose of scientific study is not mainly a mastery of the art of correct and thorough observation, not the power of extending human knowledge by discovery, not the application of established truths to useful purposes, but "tackling" a question and showing an examiner something! We submit that the curse of education in the present day is examination—in the form which it assumes in England.

Year-Book of Pharmacy: comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals, from July 1st, 1884, to June 30th, 1885, with the Transactions of the British Pharmaceutical Conference at the Twenty-second Annual Meeting, held at Aberdeen, September, 1885. London: J. and A. Churchill.

IN that part of the present volume which comprises extracts from memoirs read before the learned societies, or published in the scientific journals, we are glad to note a generally good classification. Processes for the manufacture or for the analysis of non-pharmaceutical products are no longer found under the heading "Pharmacy." "Bibliography" is a very useful chapter, giving, as it does, the titles of all the most important works on Chemistry which have appeared during the past twelve months.

In the *Transactions* we note with pleasure the absence of any proposals for more stringent regulations on the sale of poisons, seeing that no further steps can be taken in that direction without seriously interfering at once with industry and with scientific research. The latter consideration, indeed, would weigh very lightly with the Legislature.

Mr. W. Gilmour communicated an interesting paper on Cotton-seed Oil. This oil, when refined, has the mean specific gravity of 0·920 to 0·921. It ranks midway between the drying and the non-drying oils. For dietetic purposes it must be well adapted, as it has no disposition to become rancid even on prolonged exposure to sunshine. It does not saponify readily, at least in an unmixed state. Oil from the Egyptian seed is said to be superior to the American product.

Mr. D. B. Dott gives the volatilisation of mercuric chloride as 0·0088 per cent daily.

Mr. M. Dechan read a paper on Carmine. Like Dr. Hugo Müller, he had vainly tried to prepare carmine by Madame Cenette's process, "the only and invariable result being a rich crop of mould." He seems to have noticed the presence of lime as well as alumina combined with the colouring-matter; it is soluble in ammonia. He refers, however, to a novel possible adulteration. Tin spirits form with aniline scarlet a compound which much resembles carmine physically and chemically, being, like it, soluble in dilute ammonia, but insoluble in water. Hence a sample which dissolves without residue in dilute ammonia is not necessarily genuine. One sample examined contained 50 per cent of vermilion.

University College of South Wales and Monmouthshire. The Calendar. Third Session, 1885—1886. Cardiff: Daniel, Owen, and Co., Limited.

THE constitution of this College seems very complicated, there being a Court of Governors, a Council, and a Senate, the powers and duties of which bodies do not seem defined with sufficient clearness. In most Universities one ruling body, the Senate, is amply sufficient. Neither in the Court of Governors nor in the Council do we detect the names of any eminent scientific men. There are a few medical practitioners, but lawyers and ministers of all denominations seem to exceed them in number. As regards the professorial staff there are chairs of physics, of chemistry, and of biology, each Professor in the two former departments being assisted by a Demonstrator. Six professorships are devoted to languages, one to logic and philosophy, and one to mathematics and astronomy. There is also the English peculiarity, so perplexing to foreigners, of a professorship of music.

In chemistry there are three courses of instruction,—a junior, an intermediate, and a senior. For the second of these courses the authorised text-books are Thorpe's "Manual of Inorganic Chemistry" or Kolbe's "Inorganic Chemistry," with, for more advanced work, Miller, vol. ii., or Roscoe and Schorlemmer, vols. i. and ii. For chemical theory Tilden's "Chemical Philosophy," and Wurtz on the Atomic Theory are recommended, Mr. Pattison Muir's work being curiously passed over.

The senior course is devoted to organic chemistry. The text-books selected are Armstrong's and Fownes's, and for more advanced work Roscoe and Schorlemmer, vol. iii., or Miller, vol. iii. The laboratory is fitted with twenty-two work-benches. Every student who works twelve hours weekly, or upwards, has a separate bench.

The library appears fairly well stocked, as far as the number of books is concerned, but philology, history, &c., decidedly preponderate over the physical and natural sciences.

Whether the University College of South Wales will become a focus of research time only can decide.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 6, February 8, 1886.

Process for Preparing Ortho-phosphoric Acid and for Titrating Phosphoric and Arsenic Acids by means of Various Indicators.—A. Joly.—The author dissolves in heat pure ammonium monophosphate in strong hydrochloric acid. Ammonium chloride, sparingly soluble in the strong acid, is deposited. The acid liquid is phosphoric acid mixed with hydrochloric acid and still retaining some ammonium chloride in solution. This liquid is decanted, the sal-ammoniac is drained with the filter-pump, repeatedly washed with a little hydrochloric acid, and all the acid liquids are collected in a porcelain capsule, slightly heated, and mixed with nitric acid in small successive portions, so as to destroy the ammonia and gradually expel the hydrochloric acid. When this acid has been entirely eliminated the evaporation is completed in a platinum capsule. The excess of nitric acid is thus expelled and there remains a syrupy liquid which may serve for the preparation of the two crystalline hydrates of ortho-phosphoric acid. If the ammonium phosphate is arsenical, which is very frequently the case, this impurity must first be removed. Phosphoric acid may be titrated with caustic alkali with a degree of precision which is sufficient in most cases, using as indicator orangé No. 3. Phenol-phthalein gives very imperfect results, for the final colouration passes from light violet to a violet red. As for the blue C_4B, the reactions of which have been studied by M. Engel, it does not seem to the author to admit of precise applications. The volumes of one and the same solution of soda (1 eq. = 2 litres) indicating the saturation of 50 c.c. of a solution of phosphoric acid (1 eq. = 6 litres) are, with orangé, 19·9 c.c.; with phenol-phthalein, 39·2 and 40·1; and with blue C_4B 41·0. Arsenic acid gives almost identical results, yet the uncertainty of the change with orangé; the liquor changes colour with phenol-phthalein before two eq. of base have been added, and in presence of blue C_4B the change of tint shows itself a little later than that with phenol-phthalein. For titrating the solutions of arsenic and phosphoric acid in order to study the composition of their hydrates the author has for a long time made use of a more precise method. After having mixed the acid liquid with some drops of phthalein he adds a standard solution of baryta until a gelatinous precipitate is distinctly formed. This precipitate is a tribarytic salt which, in contact with the surrounding acid liquid, is converted spontaneously, or by agitation, into a crystalline bibarytic salt. On slowly adding baryta water we obtain a new gelatinous precipitate, and the operation is complete when a drop of baryta gives an intense and persistent red colour. The transformation of the gelatinous precipitate is particularly rapid with arsenic acid, and this is the only method of titration which it is possible to employ.

Action of Acetic Acid upon Oil of Turpentine.—MM. Bouchardat and Lafont.—Acetic acid combines with oil of turpentine even in the cold, yielding mono-acetates belonging to two quite distinct series. The uncombined oil is transformed into two carbides, $C_{20}H_{16}$, the one monovalent, analogous to turpentine, the second bivalent, or an active terpilene.

Die Chemische Industrie.
Vol. ix., No. 1, January, 1886.

Attempt at a Qualitative Analysis of the Commercial Coal-Tar Dyes.—Dr. Otto N. Witt.—A useful but extensive survey of the reactions of the principal coal-tar colours, other than those of the anthracene group, which will be inserted at some length as early as possible.

On Chlorozone.—G. Lunge and L. Landolt.—The authors point out that two modifications of chlorozone occur in commerce; the one recently examined by L. Storck, consisting of sodium hypochlorite, chloride, and hydroxide, and that examined by the present authors, and consisting essentially of free hypochlorous acid and sodium chloride.

The History of the Ammonia-Soda Process.—Ludwig Mond.—The author refutes the claims advanced by MM. Fremy, Bouley, and Scheurer-Kestner on behalf of MM. Schlœsing and Rolland, and shows from patent specifications that this process was invented by Harrison, Grey, Dyar, and John Hemming, and patented June 30th, 1838, whilst Schlœsing's patent was only taken out in 1854, and that of Schlœsing and Rolland in 1858.

Bulletin de la Société Chimique de Paris.
Vol. xliv., No. 8, Nov. 5, 1885.

Purification of Sulphuric Acid and Preparation of Nitric Acid.—Prof. Kupferschlæger.—All chemists know that commercial sulphuric acid, prepared from iron pyrites, contains lead and calcium sulphates, nitrous and sulphurous vapours, arsenic acid, sometimes selenious acid, thallium sulphate, and hydrogen fluoride. For its purification the author dilutes it with its own weight of water, then passes through it in excess a current of washed sulphurous acid, so as to bring the arsenic and nitric acids to a lower stage of oxidation, and to reduce selenious acid if present. A current of hydrogen sulphide is then passed through it twice, with an interval, each time as long as it is absorbed. The vessel is then closed, and allowed to stand for some time at a moderate temperature, so that the lead and arsenic sulphides, selenium, &c., may subside. The sulphuric acid is then rectified in glass retorts, applying the heat so as to reach the upper portion only.

Revue Universelle des Mines, de la Metallurgie, &c.,
Novembtr and December, 1886.

This issue contains no original chemical matter.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 3, February 5, 1886.

Contributions to the History of Sulphur and Mercury.—M. Berthelot.—Pure sulphur sublimes slightly at 60°, carrying along with it mechanically small quantities of fixed matters. The vapour-tension of this slow sublimation effected at 380° below the boiling-point is not appreciable by manometric measurements. The evaporation of mercury at common temperatures is known; and the vapour-tension of mercury, calculated according to Regnault's formulæ, would be at 20° 0·0268 metre.

On Oxalic Acid in Vegetation: Methods of Analysis.—MM. Berthelot and André.—Already noticed.

On Carbonates in Living Plants.—MM. Berthelot and André.—Plants contain carbon principles capable of being split up under the influence of natural ferments or on prolonged ebullition, yielding alkaline carbonates, or rather bicarbonates.

Direct Fixation of Free Atmospheric Nitrogen by certain Clay Soils.—M. Berthelot.—Already noticed.

Solubility of Copper Sulphate in presence of Ammonium Sulphate.—R. Engel.—Increasing quantities of ammonium sulphate precipitate copper sulphate in the state of a double salt.

Observations on the Nature and the Properties of the Alkaloids.—M. Oechsner de Coninck. The com

pounds which have been termed volatile alkaloids are pyridic or dipyridic hydrides. The so-called fixed alkaloids are bodies with a double nucleus, either hydro-dipyridic or hydro-diquinoleic, or with a double mixed nucleus both hydro-pyridic and hydro-quinoleic, nuclei whose hydrogen is substituted by one or more oxygenated radicles, and containing hydroxyls either of a phenic or an alcoholic function. The alkaloids are in general transformed by oxidation, either partially or totally, into pyridine-carbonic or quinoleine-carbonic acids. An alkaloid is a nitrogenous substance which oxidising agents convert into pyridine-carbonic or quinoleine-carbonic acids, or into a mixture of one of these acids and of a fatty or an aromatic acid.

The Law of Thermic Constants.—D. Tommasi.—M. Tscheltzow has recently determined the combination-calories of certain picrates. The values which he has obtained by means of the calorimeter are the same as the combination calories which the law of thermic constants enabled the author to foresee more than two years ago. The memoir concludes with this remark:—M. Berthelot maintains that the law had been previously known. But if so, why did it not figure in his "Traité de Mecanique Chimique"?

Electrolysis of certain Chemical Compounds.—D. Tommasi.—The author studies the electrolysis of potassium chlorate and perchlorate, and of chloral hydrate. In the latter decomposition chlorine goes to the kathode along with hydrogen, but these two elements remain in presence of each other without combining.

Combinations of Gold Trichloride with Sulphur and Selenium Tetrachlorides.—L. Lindet.—The combinations of gold trichloride with phosphorus perchloride, and with sulphur and selenium tetrachlorides, demonstrate that gold trichloride may play the part of a basic chloride in double compounds. The compounds previously obtained of gold chloride with the alkaline, alkaline-earthy, and metallic chlorides caused it to be regarded as an acid chloride. Gold trichloride is therefore indifferent, like auric acid.

New Solvents of Anhydrous Gold Trichloride.—L. Lindet.—Certain acid chlorides do not enter into combination with gold trichloride, but dissolve it, and allow it subsequently to crystallise out on cooling. Such chlorides are arsenic trichloride, silicon tetrachloride, antimony pentachloride, tin and titanium dichlorides.

MISCELLANEOUS.

The late Mr. A. Tribe.—The recent unexpected death, at the age of 46, of Mr. Alfred Tribe, has left a widow and four children in decidedly straitened circumstances. The eldest son being barely sixteen and not strong, is not yet able to contribute to the support of the family; in addition, there are two girls of 7 and 8 respectively, and a baby boy of 2 years. It has accordingly been thought desirable that a fund should be raised to aid in their maintenance and education, and for this purpose a Committee has been formed. The large amount of scientific research conducted during upwards of 20 years past by Mr. Tribe (partly published by himself, partly in conjunction with Dr. Gladstone, F.R.S), on subjects chiefly connected with various branches of chemical and electrical science, is well known to those interested in such matters: whilst for many years past Mr. Tribe was Chemical Lecturer at Dulwich College and Lecturer on Dental Metallurgy at the National Dental Hospital; and in these capacities became well known to and highly esteemed by a large number of students and pupils. Subscriptions will be gladly received at our Office, or they can be sent to Dr. Alder Wright, Chemical Laboratory, St. Mary's Hospital, W.

MEETINGS FOR THE WEEK.

MONDAY, March 1.—London Institution, 5.
—— Society of Arts, 8. (Cantor Lectures). "Science Teaching," by Prof. F. Guthrie, F.R.S.
—— Society of Chemical Industry, 8. "Ice Making and Cooling Machinery," by T. B. Lightfoot, M.I.C.E.
—— Medical, 8.30. (Anniversary).
—— Royal Medical and Chirurgical, 8. (Anniversary).
TUESDAY, 2nd.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum," by C. T. Newton, C.B.
—— Society of Arts, 8. "Bechuanaland and Austral Africa," by John Mackenzie.
WEDNESDAY, 3rd.—Society of Arts, 8. "Calculating Machines," by C. V. Boys.
THURSDAY, 4th.—Royal, 4.30.
—— London Institution 7.
—— Royal Institution, 3. "The Ancient Geography of Britain," by Prof. W. Boyd Dawkins, F.R.S.
—— Parkes Museum of Hygiene, 8. "Metropolitan Defences against Infectious Diseases," by Shirley Murphy.
—— Chemical, 8. Ballot for the Election of Fellows. "On the Influence of Temperature on the Heat of Chemical Combination," by S. U. Pickering. "The Action of Heat on the Salts of Tetrethyl-Phosphonium," by N. Collie. "On a New Method for the Preparation of Tin Tetrethyl," by Dr. Letts and N. Collie. "Contribution to History of Cyanuric Chloride and Cyanuric Acid," by Alfred Senior, M.D. "Contributions to the Knowledge of Cyanuric Derivatives," by Harold Fries.
FRIDAY, 5th.—Royal Institution, 9. "Anatomical and Medical Knowledge of Ancient Egypt," by Prof. Macalister, F.R.S.
—— Geologists' Association, 8.
SATURDAY, 6th.—Royal Institution, 3. "The History of Geometry," by Rev. C. Taylor.

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THE CHEMICAL NEWS.

VOL. LIII. No. 1371.

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

THE chemical changes resulting from the action of unorganised ferments are among the most interesting and important of those which occur in the animal organism. Ferment action plays such an important part in the chemical processes incident to life that definite knowledge of the conditions favourable and inimical to the action of any ferment occurring in the animal body must necessarily be of great physiological value.

Since Leuchs, in 1831, discovered the diastatic action of saliva much has been learned regarding this digestive fluid, both as to its chemical action and the nature of the products formed. Still there has been lacking, until recently, definite knowledge of the conditions which influence the diastatic action of the salivary ferment; and it has been the object of the present investigation, taking advantage of previously acquired knowledge, to ascertain the exact influence of those conditions which suggest themselves as being most important in view of the destination of the ptyalin, and concerning which there has been of late a lack of agreement.

Method used in Determining the Rate of Diastatic Action.

In testing the rate of action of the salivary ferment we have in all cases employed quantitative methods, similar in their general nature to those previously used by one of us.† The amount of reducing substances formed by the amylolytic action of the ferment, which for the sake of convenience we have calculated as dextrose, admit of accurate determination by means of the improved Allihn's‡ method, and thus enable us to give a concise expression of the relative diastatic action, even in those cases where the differences are very slight. As recent experiments|| have plainly indicated, the ultimate product of the diastatic action of ptyalin is dextrose; the sugar intermediate between this body and the dextrins, and which is formed in much larger quantity, is maltose, with a relative reducing power of 66 as compared with dextrose, 100; while the achroodextrins and other intermediate products have very small reducing power: consequently the reducing power of a digestive mixture must necessarily express the relative diastatic action of the ferment present, since increased action means an increased formation of reducing bodies, of which the final product has the highest reducing power. In this connection it is well to remember that diastase and ptyalin both convert only a limited quantity of starch into sugar or reducing bodies,§ and that no matter how great the excess of ferment, or the length of time the action is continued, the percentage of starch changed into sugar does not ordinarily exceed 53 per cent.¶ The general method employed in our work for testing the diastatic action of saliva was as follows:—The volume of the digestive mixture was in every instance 100 c.c.; the amount of starch* present, 1 or 2 grms., previously boiled in a definite amount of water; the temperature of digestion 38° to 40° C.; the length of time generally 30 minutes. When the digestion was finished, diastatic action was at once stopped by boiling the mixture; when cold the mixture was diluted with distilled water to 200 c.c. and filtered; 25 c.c. of the filtrate, or one-eighth of the entire fluid, was then precipitated with Fehling's solution according to Allihn's† data and method; the reduced copper was filtered through an asbestos filter in a small weighed glass tube, and ignited directly in a current of hydrogen gas and weighed as metallic copper. By means of Allihn's tables of reduction equivalents the corresponding amount of sugar, calculated as dextrose, is easily obtained, from which the percentage amount of starch converted into reducing bodies can be computed, calling dextrose $C_6H_{12}O_6$, and the starch $C_6H_{10}O_5$.‡ The following experiment illustrates the accuracy of the method and the reliance which can be placed upon it; two solutions of 100 c.c., each containing 2 grms. of starch and 4 c.c. of filtered saliva, were warmed at 40° C. for four hours, then examined with the following results:—

	Wt. Cu in one-eighth.	Total amount of Sugar.	Starch converted into Sugar.
I.	0·1530 grm.	0 6248 grm.	28·13 per cent.
II.	0·1523 ,,	0·6216 ,,	27·91 ,,

Relation of Dilution to Diastatic Action.

It is a fact well understood that the chemical action of a ferment is out of all proportion to the amount of ferment present; indeed a given solution of a ferment can be diluted again and again without any marked difference in its chemical activity, or at least none at all proportionate to the degree of dilution. It is only when the dilution has been carried to the extreme limit that the relative power of the mixture can be taken as a measure of the amount of ferment present.

The following experiments illustrate the foregoing statement. Each digestive mixture was 100 c.c. in volume, and was warmed at 40° C. for thirty minutes. The only variations in the different mixtures consisted in the amount of saliva and starch.

SERIES I.

With 1 per cent starch.

	Wt. Cu in one-eighth.	Total amount of Sugar.	Starch converted into Sugar.
20 c.c. saliva ..	0·0951 grm.	0 3872 grm.	34·87 per cent.
10 ,, ..	0·0878 ,,	0·3584 ,,	32·26 ,,
5 ,, ..	0·0809 ,,	0·3296 ,,	29·67 ,,
4 ,, ..	0 0710 ,,	0·2904 ,,	26·14 ,,
3 ,, ..	0·0635 ,,	0·2608 ,,	23·48 ,,
2 ,, ..	0·0452 ,,	0·1880 ,,	16·92 ,,
1 ,, ..	0·0178 ,,	0·0792 ,,	7·23 ,,
½ ,, ..	0·0080 ,,	0·0408 ,,	3·66 ,,

With 2 per cent starch.

20 c.c. saliva ..	0·1784 grm.	0·7304 grm.	32·87 per cent.
10 ,, ..	0·1641 ,,	0·6704 ,,	30·18 ,,

SERIES II.

a. With 1 per cent starch and 30 minutes at 40° C.

	Wt. Cu in one-eighth.	Total amount of Sugar.	Starch converted into Sugar.
4 c.c. saliva ..	0·0721 grm.	0·2944 grm.	26·50 per cent
2 ,, ..	0·0480 ,,	0·1992 ,,	17·93 ,,
1 ,, ..	0·0211 ,,	0·0920 ,,	8·28 ,,

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.

† Chittenden and Griswold, *Amer. Chem. Journ.*, iii., 305. Chittenden and Ely, *ibid.*, iv., 107.

‡ *Zeitschrift fur Analytische Chemie*, 22 Jahrgang, p. 448.

|| v. Mering and Musculus, *Zeitschrift fur Physiologische Chemie*, i., 395. O. Sullivan and E. Schultze, *Berichte d. Deutsch. Chem. Gesell.*, vii., 1047. Musculus and Gruber, *Zeitschrift f. Phys. Chem.*, ii., 177. v. Mering, *Zeitschrift f. Phys. Chem.*, v., 196.

§ Schulze and Märker, *Chem. Centralbl.*, 1872, 823. Chittenden and Ely, *Amer Chem. Journ.*, iv., 120.

¶ Musculus and v. Mering, *Zeitschrift f. Phys. Chem.*, ii., 415.

* The starch was exactly neutral; made so by long and thorough washing with pure water.

† *Loc. cit.*

‡ The actual amount of starch changed is, however, somewhat greater than would appear by this equation, since, as has already been mentioned, considerable of the sugar formed is maltose, which has only two-thirds the reducing power of dextrose.

b. With 2 per cent starch and 30 minutes at 40° C.

	Wt. Cu in one-eighth.	Total amount of Sugar.	Starch converted into Sugar.
4 c.c. saliva ..	0·1006 grm.	0·4088 grm.	18·40 per cent.
2 ,, ..	0·0408 ,,	0·1704 ,,	7·67 ,,
1 ,, ..	trace	—	—

c. With 1 per cent starch and 10 minutes at 40° C.

4 c.c. saliva ..	0·0573 grm.	0·2352 grm.	21·15 per cent.
2 ,, ..	0·0213 ,,	0·0928 ,,	8·35 ,,
1 ,, ..	0·0091 ,,	0·0456 ,,	4·11 ,,

SERIES III.

a. With 1 per cent starch and 30 minutes at 40° C.

4 c.c. saliva ..	0·0650 grm.	0·2664 grm.	23·98 per cent.
2 ,, ..	0·0313 ,,	0·1336 ,,	12·01 ,,
1 ,, ..	0·0139 ,,	0·0644 ,,	5·79 ,,

b. With 2 per cent starch and 30 minutes at 40° C.

4 c.c. saliva ..	0·0769 grm.	0·3136 grm.	19·26 per cent.
2 ,, ..	0·0250 ,,	0·1080 ,,	4·86 ,,
1 ,, ..	0·0103 ,,	0·0504 ,,	2·27 ,,

c. With 2 per cent starch and 4 hours at 40° C.

4 c.c. saliva ..	0·1530 grm.	0·6248 grm.	28·13 per cent.
2 ,, ..	0·1058 ,,	0·4312 ,,	19·41 ,,
1 ,, ..	0·0681 ,,	0·2784 ,,	12·53 ,,

From these results it is seen that only when the dilution of normally alkaline saliva is as 1 : 50 or 100 does the diastatic action at all correspond to the amount of ferment present. The same is to be noticed in Grützner's* experiments, where the principle employed by Gruenhagen in the estimation of pepsin was used, the amount of starch dissolved by the saliva being directly proportional to the amount of ferment only when very small quantities of saliva were employed and the time limited to ten or fifteen minutes. Increasing the amount of starch beyond 1 per cent tends to diminish somewhat the amount of sugar formed in a given time, when the dilution of the saliva is as 1 : 50 or 100, which fact agrees well with what we already know concerning the influence on ferment action of the clogging of digestive fluids in general by the products of digestion, or by the substance to be digested; Series III., *a* and *b*. Increasing the length of time for the ferment to act, however, causes a corresponding increase in the amount of sugar formed, as is well seen in Series III., *c*. It would not be at all impossible, therefore, by suitable dilutions, to use this method as a means of determining the relative amounts of ptyalin present in different salivary or pancreatic secretions. The following results, taken from those already given, in addition to others, lends favour to this view. All the experiments were made in the usual way, and the results are expressed in percentage of starch converted into sugar.

	I.	II.	III.
2 c.c. saliva	12·01 p.c.	8·35 p.c.	4·73 p.c.
1	5·79	4·11	2·21
	IV.	V.	VI.
1 c.c. saliva	6·93 p.c.	26·81 p.c.†	24·00 p.c †
½	3·56	13·72	11·34

The degree of dilution to be employed depends, of course, upon the amount of ferment present. We have usually diluted the saliva 5 or 10 times, and then added an amount of the diluted fluid corresponding to 0·5—2·0 c.c. of saliva, which in the 100 c.c. of digestive mixture makes a dilution of from 50 to 200. As we shall have occasion to state later on, neutralised saliva needs even a greater dilution. The method certainly appears as advantageous as that proposed by Dr. Roberts‡ a few years ago, and has the advantage of giving gravimetric results, instead of being dependent upon the disappearance of a shade of colour. In using the method with different solutions it will always be found necessary to exactly neutralise the ptyalin-containing solutions before diluting them, since variations of alkalinity, even though infinitesimal in amount, may produce discordant results. Moreover, it is better to warm the ptyalin solution with the starch for not longer than thirty minutes.

The amount of dilution which saliva will endure, and still show diastatic action, depends naturally upon the amount of ptyalin present in the secretion, and also upon the reaction of the fluid, whether it be alkaline or neutral. The following series of experiments show the average of our results on this point:—

SERIES IV.

Normally alkaline saliva, 1 per cent starch.

	Wt. Cu in one-eighth.	Total amount of Sugar.	Starch converted into Sugar.
1 c.c. saliva ..	0·0152 grm.	0·0704 grm.	6·33 per cent.
½ ,, ..	0·0057 ,,	0·0272 ,,	2·44 ,,
¼ ,, ..	0·0037 ,,	0·0176 ,,	1·59 ,,
1/10 ,, ..	trace } less than 1 per cent of starch converted.		
1/20* ,, ..	trace }		

It is thus seen that when the dilution is as 1 : 250 an appreciable amount of starch is converted into sugar in 30 minutes at 40° C. Even with a dilution of 1 : 1000 or 2000 a recognisable amount of sugar is formed under these conditions. This degree of dilution, however, cannot be considered as being the limit at which diastatic action will show itself, for with even greater dilutions the starch is converted into soluble modifications, coloured blue by iodine, without giving any recognisable amount of reducing substance,—that is, in one-eighth of the digestive mixture. Longer continued action at 40° C. might yield some reducing substance: it would seem, however, from our experiments, that when a certain degree of dilution is reached the action of the small amount of ferment in contact with the larger amount of starch (1 grm. is devoted exclusively to converting the granulose into soluble starch, or other like body with non-reducing action. This agrees with the results obtained by Grützner,† who found that the nature of the products obtained by the action of ptyalin was dependent upon the intensity of the ferment action; with a small amount of ferment erythrodextrin was the main product, while with a large amount of ferment sugar was mainly formed. Diminishing the amount of starch in large dilutions of the saliva tends, as might be expected to increase the amount of sugar formed.

Comparison of the Diastatic Action of Neutralised and Normally Alkaline Saliva.

Human mixed saliva, when freshly secreted, almost invariably possesses a distinctly alkaline reaction. Some time ago one of us published a series of experiments‡ on this point, in which it was shown that the average alkalinity of 51 samples of human mixed saliva, expressed as sodium carbonate, was 0·080 per cent. The extreme variations of alkalinity in the saliva from 14 individuals amounted to 0·085 per cent calculated as sodium carbonate (0·144—0·059 per cent).

We have had occasion to make determinations of alkalinity in 15 additional samples of saliva, all collected by one person. We give the results here, as affording additional data regarding the average alkalinity of this secretion. The alkalinity is calculated, as heretofore, in the form of sodium carbonate.§ The indicator used was delicate litmus-paper.

* Pflüger's *Archiv. der Physiologie*, xii., p. 294.
† Neutralised saliva.
‡ William Roberts, *Jahresbericht fur Theirchemie*, 1881, 290.

* To ensure greater accuracy the saliva was diluted ten times, and amounts of the diluted fluid added corresponding to the above.
† Pflüger's *Archiv der Physiologie*, xii., p. 297.
‡ Chittenden and Ely, *Amer. Chem. Jour.*, iv., 329
§ Undoubtedly the alkaline reaction of saliva is due in part to alkaline phosphates, and probably the percentages given are only an approximation to the truth.

Filtered Saliva.	0·2 per cent HCl used in neutralising.	Amount of alkalinity.
20 c.c.	6·25 c.c.	0·091 per cent.
40	10 70	0·078
40	12·00	0·087
25	9·10	0·116
20	6·00	0·087
20	6·25	0·091
20	6·75	0·098
20	5·30	0·077
40	12·50	0·091
20	7·00	0·102
40	12·20	0·088
20	7·80	0·113
20	6·80	0·099
20	8·30	0·120
20	7·60	0·110

Average alkalinity of the 15 samples, 0·097 per cent.

It was demonstrated some time ago by one of us* that neutralised saliva had as great a diastatic power as the unneutralised or normally alkaline. In fact, the single result which we recorded plainly indicated a greater diastatic power on the part of the neutralised saliva, since from the digestion with normally alkaline saliva, one-tenth of the mixture gave 0·0905 grm. metallic copper, while the same quantity of the saliva neutralised gave under like conditions 0·0943 grm. copper; thus showing that the alkaline saliva had converted 41·58 per cent of the starch into sugar, while the same quantity neutralised had changed 43·28 per cent. In these two experiments, however, the amount of saliva used was large, being one-fourth of the entire digestive mixture, viz., 25 c.c.

Recently Langley and Eves† have made the statement that "neutralised saliva converts starch into sugar much more actively than unneutralised saliva," without, however, giving any data. These are the only two statements recorded bearing on the relative diastatic action of the neutralised and normally alkaline secretion.

Our experiments, however, show that there is a very great difference in the action of ptyalin in neutralised and unneutralised saliva; a difference which is more manifest when the saliva is greatly diluted and seemingly out of all proportion to the amount of alkali present, in cases where the dilution is 1:100 or more. The following experiments show the amount of difference.

SERIES V.

The saliva used in this series contained 0·091 per cent alkali, calculated as sodium carbonate:

20 c.c. of the saliva were diluted to 100 c.c. and used in *a*.

20 c.c. of the same saliva were neutralised and then diluted to 100 c.c. and used in *b*.

a. Normally Alkaline Saliva.

	Wt. Cu in one eighth.	Total amount of sugar.	Starch converted into sugar.
4 c.c. saliva ..	0·0652 grm.	0·2672 grm.	24·05 per cent.
2 „ ..	0·0282 „	0·1208 „	10·87 „
1 „ ..	0·0094 „	0·0464 „	4·17 „

b. Neutralised Saliva.

4 c.c. saliva ..	0·0867 grm.	0·3536 grm.	31·83 per cent.
2 „ ..	0·0730 „	0·2984 „	26·72 „
1 „ ..	0·0373 „	0·1560 „	14·04 „

The difference in diastatic action in this instance, particularly where the dilution is as 1:50 and 100, is very great, yet in the case of the greatest dilution of the unneutralised saliva the alkalinity of the digestive mixture is but 0·00091 per cent calculated as alkaline carbonate. Moreover, there is a greater proportional diminution of diastatic action in this case, and also in the next greatest dilution where the amount of alkalinity is 0·00182 per cent, than in the presence of 0·00364 per cent; a fact due either to the greater susceptibility of the ferment to alkaline carbonate in a dilute solution or else to some modifying influence of the larger amount of albuminous matter present, a point which we shall return to later.

Carrying the dilution of the saliva still further we find that the difference between the diastatic action of the neutralised and unneutralised fluid shows itself to the limit of decisive diastatic action.

SERIES VI.

This sample of saliva contained 0·116 per cent of alkali calculated as sodium carbonate. The percentages of starch converted into sugar during 30 minutes at 40° C. alone are given.

Amount of saliva.	Alkali in the 100 c.c. of digestive mixture.	Alkaline saliva.	Neutralised saliva.
1 c.c.	0·00116 p.c.	6·33 p.c.	16·34 p.c.
½	0·00058	2·44	6 62
¼	0·00029	1·54	2·07
1/10	0·00011	trace	result lost
1/20	0·00005	trace	1·25 p.c.

Thus in a dilution of 1:2000 in the case of neutralised saliva, diastatic action is still sufficiently pronounced to convert 1·25 per cent starch into sugar during 30 minutes warming at 40° C.

The above results indicative of such a marked susceptibility of the ferment in a dilute solution to the action of the alkali naturally present in saliva, suggest the possibility of there being a direct connection between the alkalinity of the natural secretion and its diastatic power. While the results already given plainly indicate that very slight changes in the alkalinity, everything else being equal, materially modify the diastatic power of the fluid; still the amount of ferment itself, as well as the amount of proteid matter, may vary in different salivas so much as to counterbalance the direct influence of changes in the alkalinity.

This, the results of our experiments seem to indicate, as we have been unable to trace out any direct connection between the natural variations of alkalinity and diastatic action.*

(To be continued).

* Chittenden and Ely, *Amer. Chem. Jour.*, iv., 112.

† On certain conditions which influence the amylolytic action of saliva. *Journal of Physiology*, vol. iv., No. 1.

* Compare Chittenden and Ely, *Amer. Chem. Jour.*, iv., 329.

ANALYSES OF COMMERCIAL FERTILISERS.†

On Phosphoric Acid.

DR. JENKINS, chairman, presented the Report of the Committee on Phosphoric Acid.

As required by the Constitution of the Association, the Committee on Phosphoric Acid herewith presents its Report. The Report covers (1) a brief notice of new analytical methods proposed for determining phosphoric acid; (2) a report of some work done during the past year by the committee and members of the Association; and (3) recommendations for the next year.

Henry Pemberton, jun. (*Journ. of Franklin Institute*, CHEMICAL NEWS, 46, and cited in *Fres. Zeitschr. f. Anal. Chem.*, xxiii., 69), determined phosphoric acid volumetrically. A solution of ammonium molybdate of known strength is added to the phosphate solution till the phosphoric acid is completely removed.

Eighty-nine and five hundred and forty-three one-thousandths grms. of ammonium molybdate are dissolved in 1 litre of water. If necessary to secure a clear solu-

† From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

tion, a little ammonia is added before filling up to the litre mark. One c.c. of this standard solution corresponds to 0·003 grm. of P_2O_5, since under the conditions here to be given the yellow precipitate will contain phosphoric acid and molybdic acid in the ratio of 1 : 24.

The P_2O_5 (about 0·1 grm., or at most 0·15 grm.) should be in solution in nitric acid, and free from organic matter and silica.

The concentrated solution, in a beaker of 100 to 125 c.c. capacity, is neutralised as nearly as possible, and to it are then added 2 c.c. of nitric acid, of sp. gr. 1·4, and 10 grains of crystallised ammonium nitrate. The solution is heated to 60° C., and the standard molybdic solution is run in, with constant stirring, till all the P_2O_5 is separated.

To determine this point of complete separation the author, after each addition, filters a small quantity, heats to 60° C., and observes whether adding more of the standard solution produces a further precipitation. From the number of cubic centimetres used 5 c.c. is deducted, that being the amount which experiments have shown is necessary in excess to secure perfect precipitation.

Otto Freiherr von der Pfordten (Inaugural Dissertation, *Fres. Zeitschr. für Analyt. Chem.*, xxiii., 422) proposes a volumetric method for the determination of P_2O_5. He secures the precipitation of ammonium phospho-molybdate without free molybdic acid in it. By zinc and hydrochloric acid he reduces the combined molybdic acid of the precipitate to the suboxide Mo_5O_7, which in the air at once passes into the sesquioxide Mo_2O_3, and then by a standard solution of potassium permanganate he determines the amount of oxygen necessary to oxidise the Mo_2O_3 to molybdic acid. From this the amount of phosphoric acid can be reckoned.

The details of the method are as follows:—Phosphoric acid is precipitated as ammonium phospho-molybdate. Particulars with regard to the precipitation are not given in the abstract, but no doubt the method employed by Pemberton, which has been already described, will answer here. The precipitate is washed out on the filter-pump with a nearly saturated solution of ammonium sulphate, until a drop of the filtrate no longer shows a dark brown colouration when ammonium sulphide is added to it. The precipitate is dissolved in a small quantity of ammonia, the solution is brought to a definite volume, and an aliquot part is taken which should contain not more than 0·3 grm. MoO_3. In any case not more than 30 c.c. should be used, otherwise the solution is too dilute. To this solution in a small flask are added 50 to 60 c.c. 27 per cent HCl, and 8 to 10 grms. of zinc in stick form, whose content of iron has already been determined by titration. When the solution has a yellow colour the flask is cooled before all the zinc is exhausted, and its contents are rinsed into a porcelain dish containing 40 c.c. dilute H_2SO_4, and 20 c.c. of a solution of 200 grms. $MgSO_4$ in 1 litre. The solution is at once diluted with water to 500 c.c., and titrated with a standard solution of potassium permanganate. From the number of cubic centimetres required for oxidation must be deducted the amount used in the oxidation of the iron which may exist as an impurity in the zinc.

Van der Pfordten finds in the yellow precipitate the same relation (1 : 24) between P_2O_5 and MoO_3 that was found by Finkner and H. Pemberton, jun.

The ammonia and water contents of the precipitate are variable.

C. Morh (*Zeitsch. für Anal. Chem.*, xxiii., 487) describes a method for the extraction of "reverted" P_2O_5 by means of an alkaline ammonium-citrate solution, and subsequent determination of the soluble and reverted together by the molybdate method, after oxidising the organic matter with fuming nitric acid. This has at present no special interest for us, since the method of extraction is so entirely different from the one adopted by this Association.

David Lindo (Chemical News, xxxviii., 1884, 247, cited in *Biedermann's Centralblatt fur Ag. Chem.*, 1884, 642), by careful experiments, shows the value of his so-called "oxalate method," which consists in removing CaO as oxalate in a neutral solution of the phosphate, after separating silica, and then precipitating P_2O_5 by magnesia mixture with the addition of some citric acid. The method gives good results even where the iron oxide is present with silica; but if alumina is present with silica the results will come too high.

Lindo also shows that the molybdate method in the presence of *small* amounts of silica will give accurate results, but not if a considerable quantity of SiO_2 is present. In one experiment the presence of 0·008 grm. SiO_2 and 0·04 grm. Al_2O_3 did not interfere with the accuracy of the determination.

J. S. Wells (*Journ. Chem. Soc.*, 1885, 185, papers) proposes a method which is more rapid than the ammonium-molybdate method. He prepares two solutions:—

A contains 900 grms. of citric acid in 500 c.c. of water and 1400 c.c. of ammonia solution, sp. gr. 0·92.

B is a strong solution of magnesium citrate.

One grm. of the fertiliser is fused with 3 to 4 grms. of Na_2CO_3 and 3 to 4 grms. $NaNO_3$. The fused mass is dissolved in nitric acid and filtered. To this phosphate solution is added enough of A to prevent any precipitation of phosphates when the solution is made alkaline. This usually requires about 10 c c.

After making it alkaline the whole is allowed to stand thirty minutes. If any silica separates in that time it is filtered off. Then enough of B is added to precipitate all of the P_2O_5, and, after stirring vigorously and allowing it to stand for some time, the precipitate is filtered and weighed.

The author states with *naiveté* that if the phosphate is not fused too long the silica will remain insoluble, and "care must be taken not to mistake a possible precipitate of magnesic phosphate for one of silica."

John Ruffle (Chemical News, 51, 63) calls attention to the necessity of separating silica in all cases after boiling a phosphate with HCl, before precipitating with magnesia mixture. With the same phosphate he finds differences in some cases of nearly 1 per cent of P_2O_5, depending on whether SiO_2 has or has not been separated. The results come too high when the silica separation is omitted.

(It is not evident whether the "molybdate" method or the so-called "citric method" was used in the experiments reported.)

G. L. Spencer (*Chem. Centr.*, 1884, 445; *Journ. Chem. Soc.*, 1885, 436, abstracts) separates P_2O_5 by silver carbonate, and determines it volumetrically by a solution of uranium acetate; 5 to 20 grms. of the fertiliser are ignited till the ash is white, dissolved in strong HNO_3, diluted, filtered, and washed. By this means the larger part of the iron is separated and the chlorides are decomposed. To an aliquot part of the whole, which should contain from 0·1 to 0·5 grm. P_2O_5, a slight excess of silver carbonate is added, which forms a perfectly insoluble precipitate of silver phosphate. This is boiled with the supernatant liquid, filtered, and washed with boiling water, and then dissolved in a minimum quantity of HNO_3. The silver is thrown down by sodium chloride, the solution is neutralised with Na_2CO_3, and P_2O_5 is determined by uranium acetate.

J. Bougartz (*Arch. Phar.*, 322, 846; *Journ. Chem. Soc.*, 1885, 438, abstracts) states that P_2O_5, either free or combined with potash or soda, may be determined volumetrically by staudard KOH or NaOH, using methyl orange or phenol-phthalein as an indicator.

If KOH is added to a solution of P_2O_5 till the red of methyl orange has changed to pale yellow, RH_2PO_4 is formed (112 parts KOH = 142 parts P_2O_5). If now phenol-phthalein is added, and the titration is continued till the red colour appears, K_2HPO_4 is formed (112 parts K_2O = 142 parts P_2O_5). If H_2SO_4 or HCl is added till the methyl-orange red reappears, the titration may be repeated. If dicalcium phosphate is dissolved in HCl, and KOH is added till methyl orange becomes yellow, the solution then contains KCl, $CaCl_2$, and $CaHPO_4$ (?).

A further addition of the alkali till phenol-phthalein shows red gives tricalcium phosphate, dicalcium phosphate, and K_2HPO_4. $2CaH_4PO_4+6KHO+2CaCl_2=$

$=Ca_3(PO_4)_2+6H_2O+CaHPO_4+K_2HPO_4+4KCl.$

168 parts KOH = 142 parts P_2O_5. If HCl is added, the titration may be repeated as before. In the presence of sufficient $CaCl_2$ monocalcic phosphate is entirely converted into tricalcium phosphate during the titration. 224 parts KOH = 142 parts P_2O_5.

By this method P_2O_5 may be readily estimated in manures:—From the HCl solution iron and alumina are precipitated as phosphates by the addition of ammonia. Aceuc acid is added to dissolve the calcium phosphate, and in a few minutes the precipitate is brought on a filter and washed till the acid reaction has disappeared.

The precipitate is dissolved in HCl and titrated. To the filtrate containing the rest of the P_2O_5 is added a little HCl and an excess of iron, aluminum, and calcium chlorides. It is heated, and the P_2O_5 precipitated by ammonia. The precipitate is brought on a filter, washed with water containing a little KOH, dissolved in HCl, and titrated after adding excess of $CaCl_2$. It is necessary that the organic matter in the fertiliser should be entirely destroyed by calcination or fusion. The standard solution of KOH must be entirely free from alumina and carbonic acid. It is best prepared from $Ba(OH)_2$ and K_2SO_4.

C. Glaser (*Fres. Zeitschr. fur Analyt. Chem.*, xxiv., 178) describes a method depending on the precipitation of P_2O_5 by magnesia mixture in the presence of just enough ammonium citrate to prevent the separation of $Ca_3(PO_4)_2$, and of enough H_2SO_4 to combine with all the lime present.

There are required—

(1.) Magnesia mixture prepared by dissolving 140 grms. $MgSO_4$, 150 grms. $(NH_4)_2SO_4$, and 30 grms. NH_4Cl in 350 c.c. ammonia solution (16 per cent), and 1650 c.c. of water.
(2.) A 50 per cent solution of cttric acid.
(3.) Dilute ammonia, 250 c.c. (16 per cent ammonia solution diluted to 1 litre.
(4.) Dilute H_2SO_4 (100 c.c. of H_2SO_4, 60° B., diluted to 1 litre).

The phosphate solution in a beaker is neutralised until turbid, and just enough citric acid solution is added to make it clear while still distinctly alkaline. This may require 3 c.c., or at most 4 c.c.

When cold the magnesia mixture is added dropwise, with constant stirring, and then ammonia in large excess. After six to eight—better twelve—hours standing the precipitate is filtered, washed with dilute ammonia, and dissolved in H_2SO_4. More magnesia solution is added, and the solution precipitated again with ammonia. The precipitate is filtered, washed, ignited, and weighed. The advantages claimed are rapidity, economy, and ease. The separation of SiO_2 is avoided, and the results are absolutely accurate.

The same author compares the method used by this Association with the "oxalate method," and finds substantial agreement in the case of superphosphates which contain only a small amount of iron.

With natural phosphates and iron phosphates the agreement is not so good. The "oxalate method" used by him consists in bringing the filter and residue from the extraction of soluble P_2O_5 into a beaker, and boiling for ten minutes with 100 c.c. of a solution of ammonium oxalate, which is saturated at ordinary temperatures. The solution is filtered, and the residue washed with hot water.

We come now to the work which has been done during the year by members of the Association.

Last November your Committee sent to eighteen official and commercial chemists two sealed samples of plain acid phosphates, one made from South Carolina rock and one from Navassa rock, and marked "South Carolina" and "Navassa." The material had been air-dried, put through a ½-inch-mesh sieve, and very thoroughly mixed. The Committee requested that determinations should be made, by the method recommended by this Association last year, of the following ingredients:—Water, soluble phosphoric acid, reverted phosphoric acid, and insoluble phosphoric acid.

In response to this request your Committee has received reports from fifteen chemists. The number of laboratories represented is twelve, for in three cases reports were sent from chemists who worked in the same laboratory, presumably with the same reagents, &c.

These reports were received at different dates from December to the last of June. On July 1st the Committee sent to each chemist who had participated in the work a tabulated statement of all the results which had been received. The names of the chemists were not given.

Some brief notice of these results may be in place here:—

(1.) The water determinations were absolutely worthless.

In "South Carolina" different chemists found from 8 to 10·50 per cent moisture; in "Navassa" from 8·65 to 9·85 per cent.

This is to be expected. An accurate water determination in a superphosphate requires more time and care than the determination is generally worth. All superphosphates contain, besides hygroscopic moisture, water in combination with calcium sulphate, produced in their manufacture by the action of sulphuric acid on calcium phosphate. This water cannot be entirely expelled at 100° C., and only very slowly, if at all, at 110° to 120° C. Now if organic matter, such as is present in an ammoniated superphosphate, is heated in air to 110° to 120°, it is more or less oxidised, and thus the accuracy of the determination is impaired.

To illustrate the uncertainty of the determination the following experiment made by the writer with "South Carolina" will suffice:—Five portions, of 1 grm. each, were dried for one, two, three, four, five hours, respectively, in an air-bath at 100° C. The results were as follows:—

Mark.	Dried for—	Loss.
A	1 hour	9·04 per cent.
B	2 hours	8·86 ,,
C	3 ,,	9·21 ,,
D	4 ,,	9·20 ,,
E	5 ,,	8·99 ,,

These results are tolerably uniform, but on continuing the drying the results were as follows:—

	A.	B.	C.	D.	E.
For 6½ hours, total loss—	9·49	9·71	9·59	9·32	9·12
For 6 hours additional, total loss—	9·79	9·77	9·82	9·96	9·67
For 8 hours additional, total loss—	10·02	9·92	10·12	10·15	10·02
For 10 hours additional at 110°, total loss—	Lost	10·29	10·37	10·30	10·07
For 6 hours additional at 110°, total loss—	—	10·39	10·37	10·30	10·27

Here the loss ceased, but if the superphosphate had contained organic matter it is hardly to be expected that the results would have been as uniform.

(To be continued.)

Influence of Acid Ammonium Oxalate upon the Solubility of the Neutral Oxalate.—R. Engel.—The quantity of one of the oxalates in solution diminishes as the other increases. On treating a saturated solution of the neutral oxalate with a little oxalic acid there is precipitated not the acid oxalate, as it is generally assumed, but neutral oxalate.—*Comptes Rendus.*

ON PLATOSO-OXALIC ACID.

By H. G. SÖDERBAUM.

Doebereiner formerly obtained by the action of oxalic acid upon the sodium salt of platinum dioxide a salt of a a copper-red colour which he regarded as platinous oxalate. Souchay and Lenssen assign it the formula $PtNa_2C_4O_8 + 4H_2O$. This salt has much analogy with the platinum sulphites, since the solution gives neither the reactions of platinum nor those of oxalic acid. We may therefore regard this componnd as the sodium salt of platoso-oxalic acid which has been isolated.

The salts of platoso-oxalic acid are very remarkable, because they occur in isomeric or rather polymeric forms.

For the preparation of the sodium salt sodium chloroplatinate is heated with an equal weight of sodium hydrate. The residue is treated with water, which dissolves out sodium chloride, leaving a yellow powder—

$$Na_2O,3PtO_26H_2O.$$

More of it is obtained by the addition of hydrochloric acid to the solution of sodium chloride, avoiding excess. It is washed with cold water and washed with 1½ part of crystalline oxalic acid. Carbonic acid escapes, and there is obtained a solution of an intense blue colour. When cold slender brown needles of a metallic lustre are deposited. This salt is collected upon a filter and repeatedly washed with boiling water. There filters first a yellow solution, then a greenish or blue one, and lastly a solution of a reddish brown. From the last liquid the mass of the sodium salt is deposited on cooling, crystallised in capillary needles of a coppery lustre. The first solution after some time deposits lemon-yellow prisms of an isomeric salt. The intermediate solutions deposit mixtures of the two salts. Both salts yield with silver nitrate a yellowish white precipitate of microscopic crystals of the silver salt of platoso-oxalic acid. On decomposing this silver salt with the calculated proportion of hydrochloric acid we obtain an indigo-blue solution containing platoso-oxalic acid. We may obtain the salts of the acid either by the double decomposition of the sodium salts or by neutralising the free acid with bases or carbonates. With the brown sodium salt there are obtained salts of a brown, greenish, or blue colour; but with the yellow salt we obtain isomeric yellow or orange salts. The free acid generally gives salts of the former class, *i.e.*, of a dark colour, but by repeated crystallisations yellow salts may be obtained. Several metals belonging to the zinc group form dark-coloured salts most readily; others, for instance silver, yield yellow salts, and others again form with equal ease either dark or yellow salts. The tri- and tetra-atomic metals give both dark and yellow salts, but of a different composition. The dark salts are in general less soluble; their density is lower and they often contain a smaller number of mols. of crystalline water. The difference between the two classes of salts does not depend on the water of crystallisation, because both dark and yellow anhydrous salts have been obtained and because there exist both yellow and dark salts containing the same number of mols. of crystalline water.

The salts of platoso-oxalic acid are in general sparingly soluble in cold dilute acids: they are insoluble in alcohol. In hot water some of them dissolve readily; others are sparingly soluble. Most of them contain crystalline water, which they lose in part or entirely at 100°. They bear the temperature of 110° to 115° (though the ammonium salt is decomposed at 100°); but a little above this temperature they begin to decompose. If suddenly heated they are decomposed with detonation.

Platoso-oxalic acid, $PtC_4O_8H_2 + 2H_2O$, the preparation of which has been described above, gives, when its solution has been evaporated in a vacuum, a red crystalline mass of a metallic lustre. It dissolves readily in water with an indigo-blue colour, but this colour changes to yellow on heating or diluting with water. Yet the blue colour returns on cooling or on concentration.

There are two potassium salts, a brown one forming copper-coloured needles of sp. gr. 3·01, and a yellow one in hexagonal prisms of sp. gr. 3·03. Both contain the same number of mols. of crystalline water. With the ammonium salts the case is similar. The dark sodium salt forms slender needles containing 4 mols. crystalline water, whilst the yellow salt forms prisms with 5 mols. of crystalline water. There are three isomeric calcium salts; the brown one with $6\frac{1}{2}H_2O$; the β-yellow salt with $4H_2O$, losing 1 mol. water at 100°; and the γ-yellow salt with $8H_2O$, losing at 100° $5H_2O$. There are also three strontium salts: α, dark, contains $3\frac{1}{2}H_2O$ and loses $\frac{1}{2}H_2O$ at 100°; β, also dark, contains $6\frac{1}{2}H_2O$ and loses $3H_2O$ at 100°; and γ, yellow, contains only 3 mols. of crystalline water and undergoes do change at 100°.

These researches were made in the laboratory of Prof. P. T. Clève.—*Bulletin Soc. Chimique de Paris*, 1886, p. 188.

THIRD REPORT OF THE COMMITTEE*

RE-APPOINTED FOR THE PURPOSE OF DRAWING UP A STATEMENT OF THE

VARIETIES OF CHEMICAL NAMES WHICH HAVE COME INTO USE,

FOR INDICATING THE CAUSES WHICH HAVE LED TO THEIR ADOPTION, AND FOR CONSIDERING WHAT CAN BE DONE TO BRING ABOUT SOME CONVERGENCE OF THE VIEWS ON CHEMICAL NOMENCLATURE OBTAINING AMONG ENGLISH AND FOREIGN CHEMISTS.†

(Continued from p. 105).

III.

1. —
2. Supersulphate of soda.
3. Bisulphate of soda.
4. Bisulphate of soda.
5. Bisulphate of soda.
6. Bisulphate of soda.
7. —
8. Bisulphate of soda.
9. Bisulphate of soda (HO,SO_3+NaO,SO_3).
10. —
11. Saures (od. doppelt) schwefelsaures Natron ($NaO,2SO_3+Aq$).
12. Schwefelsaures Natron und schwefelsaures Wasser, zweifach schwefelsaures Natron ($\dot{N}a\ddot{S}^s+3\dot{H} = \dot{N}a\ddot{S}+\dot{H}\ddot{S}+2\dot{H}$).
13. Schwefelsaures Natron, zweifach saures, wasserhaltendes Salz (NaO,SO_3+HO,SO_3).
14. Saures schwefelsaures Natron.
15. Bisulphate of soda (NaO,SO_3+HO,SO_3).
16. Bisulphate of soda (HO,SO_3+NaO,SO_3).
17. Bisulfate de soude ($NaO.SO^s+HO.SO^s+3HO$).
18. Bisulphate of soda (NaO,SO_3+HO,SO_3+3HO).
19. Zweifach schwefelsaures Natron, Wasserhaltiges (NaO,SO_3+HO,SO_3).
20. Bisulphate of soda ($NaO,HO,2SO_3$).
21. Bisulfate de soude ($NaO.SO^s+HO.SO^s+2HO$).
22. Bisulphate de soude.
23. Hydro-monosodic sulphate (hydrated bisulphate of soda) ($NaHSO_4^{\cdot}$).
24. Bisulfate de soude.
25. Saures schwefelsaures Natron.
26. Sodium and hydrogen sulphate, or acid sodium sulphate ($2SO_4NaH.3OH_2$ or $SO_4Na_2.SO_4H_2.3OH_2$).
27. Hydrosodic sulphate ($NaHSO_4$).
28. Sulfate acide de sodium (SO_4NaH).
29. Bisulphate of soda ($Na_2O,H_2O,2SO_3$).

* Consisting of Professors Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves J. Millar Thomson, H. B. Dixon (Secretary), and V. H. Veley.

† Read at the British Association, Aberdeen Meeting, Section D.

30. Mononatrium Sulfat, oder halbgesättigtes saures schwefelsaures Natrium.
31. Saures schwefelsaures Natron $SO_2\begin{cases}ONa\\OH\end{cases}$
32. Sodium and hydrogen sulphate, or acid sodium sulphate (see 26).
33. Hydric sodic sulphate (acid sulphate of sodium or bisulphate of soda) ($NaHSO_4$).
34. Hydrogen sodium sulphate ($NaHSO_4$).
35. Hydric sodic sulphate (SO_2HONao).
36. Acid sodium sulphate $SO_2\left(\begin{cases}OH\\ONa\end{cases}\right)$

IV.

1. —
2. See Table III.
3. „ „
4. „ „
5. „ „
6. Anhydrous bisulphate of soda (S+2s').
7. Bisulphas natricus $N\ddot{a}\ddot{S}_2$.
8. Anhydrous bisulphate of soda (S+2s').
9. —
10. Zweifach schwefelsaures Natron ($NaO,2SO_3$.
11. Saures (doppelt) schwefelsaures Natron, das wasserleere Salz.
12. —
13. Schwefelsaures Natron, zweifach saures wasserfreies Salz.
14. —
15. (Not specially named.)
16. Anhydrous bisulphate (a true bisulphate).
17. Un véritable bisulphate ($NaO.2SO_3$).
18. Anhydrous bisulphate of soda ($NaO,2SO_3$).
19. Zweifach schwefelsaures Natron, wasserfreies Salz ($NaO,2SO_3$).
20. Bisulphate of soda, the anhydrous salt.
21. Un véritable bisulphate ($NaO.2SO^3$).
22. —
23. Anhydrosulphate of sodium or anhydrous bisulphate of sodium ($Na_2S_2O_7 = Na_2SO_4,SO_3 = Na_2O,2SO_3$, 1875.
24. Disulfate de soude.
25. —
26. Anhydro bisulphate (SO_4Na_2,SO_3).
27. Sodic disulphate ($Na_2S_2O_7$).
28. Anhydrosulfate.
29. —
30. Neutrales Kalium Pyrosulfat.
31. Dischwefelsaures Natron $\left(O\begin{cases}SO_2ONa\\SO_2ONa\end{cases}\right)$
32. Pyrosulphate ($Na_2S_2O_7$ or Na_2SO_4,SO_3).
33. Sodic pyrosulphate ($Na_2S_2O_7$).
34. Sodium disulphate ($Na_2S_2O_7$).
35. Sodic pyrosulphate ($S_2O_5Nao_2$).
36. Sodium disulphate $\left(O\begin{cases}SO_2ONa\\SO_2ONa\end{cases}\right)$.

V.

1. (Alkaline chromats).
2. Chromate of potash [red colour].
3. Bichromate of potash.
4. (Not distinguished from chromates.)
5. Bichromate of potash.
6. Bichromate of potassa (2Chr'+P).
7. Bichromas kalicus ($\ddot{K}\ddot{C}r_2$).
8. Bichromate of potassa (2Chr'+P).
9. Bichromate of Potash ($KO,2CrO_3$).
10. Not mentioned.
11. „ „
12. Zweifach chromsaures Kali.
13. Doppeltsaures od. rothes chromsaures Kali ($KO,2CrO_3$), 1859.
14. —
15. Bichromate of potash ($KO+2CrO_3$).
16. Bichromate of potash ($KO,2CrO_3$), 1858.
17. Bichromate de potasse.
18. Bichromate of potassa ($KO,2CrO_3$).
19. Zweifach od. rothes chromsaures Kali ($KaO,2CrO_3$).
20. Bichromate of potash ($KO,2CrO_3$).
21. Bichromate de potasse.
22. —
23. Acid chromate of potassium, dichromate of potassium, or bichromate of potash ($K2O.2CrO_3 = K_2CrO_4,CrO_3$), 1863. Potassium dichromate ($K_2O.2CrO_3$), 1872.
24. Dichromate de potasse.
25. Saures chromsaures Kali.
26. Potassium bichromate or anhydrochromate ($2CrO_3,K_2O$, or CrO_4K_2,CrO_3).
27. Potassic dichromate ($K_2Cr_2O_7$).
28. Bichromate de potasse ($K_2O,2CrO_3$).
29. Bichromate of potash ($K_2O,2CrO_3$).
30. Kalium dichromat.
31. (Neutrales) Dichromsaures Kali. $\left(O\begin{cases}CrO_2OK\\CrO_2OK\end{cases}\right)$.
32. Potassium bichromate or anhydrchromate ($2CrO_3,K_2O$, or CrO_4K_2,CrO_3).
33. Potassic dichromate, pyrochromate, or anhydrochromate ($K_2O,2CrO_3$, or $K_2Cr_2O_7$).
34. Potassium dichromate, or bichromate of potash ($K_2Cr_2O_7$).
35. Dipotassic dichromate $\left(\begin{cases}CrO_2Ko\\O\\CrO_2Ko\end{cases}\right)$
36. Potassium dichromate.

VI.

1. —
2. —
3. —
4. —
5. —
6. —
7. —
8. —
9. Terchromate of potash ($KO,3CrO_3$).
10. —
11. —
12. Dreifach chromsaures Kali.
13. Dreifach chromsaures Kali ($KO,3CrO_3$).
14. —
15. —
16. Terchromate of potash ($KO,3CrO_3$) [1858].
17. —
18. —
19. Dreifach chromsaures Kali ($KaO,3CrO_3$).
20. Terchromate of potash ($KO,3CrO_3$).
21. —
22. —
23. Hyperacid chromate or trichromate of potassium ($K_2O,3CrO_3$ or $K_2CrO_4,2CrO_3$) [1863]. Potassium trichromate ($K_2O,3CrO_3$) [1872].
24. —
25. —
26. Potassium trichromate ($3CrO_3,K_2O$, or $CrO_4K_2,2CrO_3$).
27. —
28. —
29. Terchromate of potash ($K_2O,3CrO_3$),
30. Kalium trichromat.
31. —
32. Potassium trichromate ($3CrO_3,K_2O$, or $CrO_4K_2,2CrO_3$).
33. Potassic trichromate ($K_2O,3CrO_3$).
34. Potassium trichromate ($K_2Cr_3O_{10}$).

35. Dipotassic trichromate $\begin{cases} CrO_2Ko \\ O \\ CrO_2 \\ O \\ CrO_2Ko. \end{cases}$

36. —

(To be continued).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

February 27th, 1886.

Dr. J. H. Gladstone in the Chair.

The following were elected Members of the Society:—Dr. Sydney Young and Mr. D. E. Jones.

The following communications were read:—

"*The Relations of Pressure, Temperature, and Volume in Saturated Vapours.* By Prof. W. C. Unwin.

In the first part of this paper certain formulæ given by Messrs. Ramsay and Young, in a recent communication on "Some Thermodynamical Relations," are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p\frac{dp}{dt}$ is constant. Professor Unwin finds, however, that $t\frac{dp}{dt}$ is less constant than $t^2\frac{dp}{dt}$, while $\frac{t^2}{p}\frac{dp}{dt}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that—

$$\frac{t^{n+1}}{p}\frac{dp}{dt}$$

might be more nearly constant, and the integration of this gives—

$$\log. p = a - \frac{b}{t^n}$$

—a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations, in which, for convenience in calculation, the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log. p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p}\frac{dp}{dt} = 2{\cdot}3025\frac{nb}{t^{n+1}}$$

$$= 2{\cdot}3025\, n\frac{(a-\log. p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\frac{t}{p}\frac{dp}{dt} - 2{\cdot}3025\frac{nb}{t^n},$$

&c.

These formulæ have been examined in the case of steam from −30° to 230° C., and with pressures varying from 0·4 to 20,000 m.m. The constants were found to be—

$$a = 7{\cdot}5030 \qquad b = 7579 \qquad n = 1{\cdot}25$$

and the differences between the calculated results and the observations of Regnault and Zeuner rarely exceeded 1 per cent, while generally much smaller.

a, b, and n have also been found for some other substances, with the following results:—

Alcohol	$a = 7{\cdot}448$	$b = 8784$	$n = 1{\cdot}29$
Ether	$a = 6{\cdot}9968$	$b = 3047$	$n = 1{\cdot}153$
Mercury	$a = 9{\cdot}8651$	$b = 597{\cdot}5$	$n = 0{\cdot}69$
Carbonic acid ..	$a = 8{\cdot}4625$	$b = 302{\cdot}8$	$n = 0{\cdot}77$

Prof. Perry offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log. p = a - \frac{b}{t} - \frac{c}{t^2},$$

which gives p in terms of t, and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the pressure and temperature of different saturated vapours, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.

"*On a Map of the World, in which the Proportion of Areas is preserved.*" By Mr. Walter Baily.

The author has devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed, in 1729, for charting the stars in his "Atlas Cœlestis." The construction applied to the Earth is briefly as follows:—Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line: these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them: through the points so found the meridians may be filled in, and the map constructed. From the method of construction it is evident that although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rainfall, depths of sea, ocean currents, &c.

"*On a Delicate Calorimetric Thermometer.*" By Prof. S. U. Pickering.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 12, 1886.

Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.

"*Note on a Paper by Dr. T. Leone, 'On the Micro-organisms of Potable Waters, and their Life in Carbonate Waters.'*" By F. J. Faraday, F.L.S.

An interesting paper, by Dr. T. Leone, on the micro-organisms of potable waters, was recently published in the *Gazzetta Chimica Italiana*. A translation appeared in the Chemical News of December 4th last. In fulfilment of a promise to the late Dr. Angus Smith, I propose to comment on some points in this paper which have a bearing on Dr. Smith's researches. Dr. Leone observes: "Many experimentalists who have occupied themselves with the study of microbia on Koch's method, have contented themselves with the summary appreciation of the value of a potable water according to the number of microbia present, capable of producing 'colonies' in gelatin. It is believed that the bacteria derived from putrescent animal matter produce colonies which liquefy gelatin. From the number of such colonies it is believed that we may form an opinion as to the greater or less corruption of a water."

It will be remembered that in his latest *Rivers Pollution Report*, Dr. Smith gave a series of results showing the comparative purity of different waters according to this method. Dr. Leone goes on to say: "Since the majority of such experimentalists have not taken account in such researches of the time which has elapsed from the moment in which the water was obtained to that when it was experimented upon, and since these experimentalists

have ascribed to a water thousands and thousands of microbia per c.c —a water which may have required two or three days' journey from its source to the point where it comes to be examined—it is to be supposed that these experimentalists have disregarded the possibility that the purest drinking-water may be a good medium for the culture of microbia."

As regards the latter part of this passage, I wish to point out that Dr. Smith specially called attention to the fact that very pure spring water contains active microbia. Dr. Smith found that all waters gave off hydrogen when sugar was added, except distilled water and water which has been boiled, which do not give off hydrogen under the conditions specified. Dr. Smith found further that, taking a series of samples ranging from the very pure spring water of the uplands down to the most foul sewage, the quantity of hydrogen given off with sugar was apparently proportionate to the degree of contamination; and he added that, so far as he was aware, there was no water which had not previously been boiled or distilled which did not give evidence of the presence of the micro-organisms in this way. Dr. Smith showed me the proofs of his report containing these statements at the beginning of 1884; and from numerous conversations with him, I am able to say that there is no room for doubt that he was very strongly impressed with the fact that spring waters, which may be regarded as pure, offer a medium for the culture of microbia.

I have looked carefully through his report, however, in order to see if he has given there any indication of having taken into consideration, in his comparative quantitative experiments, the possibility of a considerable multiplication of the microbia during the period between the collection of the water and the application of the test, such multiplication being, of course, irrespective of any further contamination in the interval. I have no recollection of this point having been mentioned in our conversations; but as Dr. Smith was very ill at the time the report was passing through the press, our conversations were not exhaustive. In one or two cases it is stated in the report that the test was applied after the water had been allowed to stand for forty-eight hours subsequent to the collection of the sample; but this was apparently done merely in order to test the deposit, the clear water being syphoned from the top. Whether Dr. Smith took into consideration the self-multiplication of the microbia present in the samples during the different intervals of time required for their transit to his laboratory from various distances, I have not been able to make out. Owing to the unfortunate circumstances of Dr. Smith's long illness and death before the publication of the report, it is possible that matters to which he would have attended under other circumstances may have escaped record or notice. The point is an interesting one, and as some of the members of the Society, or those who assisted him in the experiments, may be able to throw further light upon it, it has appeared to me desirable to bring the matter under the notice of the Society, in order that no fact bearing upon Dr. Smith's latest inquiry, and one which he regarded with great hopefulness, may he lost.

The statements made by Dr. Leone as to the multiplication of microbia in very pure waters are remarkable. Taking the Maugfall water, which supplies the city of Munich, as a type of the purest potable waters, he collected it in vessels very carefully sterilised and protected from contamination. He gives the results of subsequent examination as follows:—"The Maugfall water arrives at Munich with five microbia per c c. After twenty-four hours, being left under the conditions above described, the number of microbia is found to have risen to more than a hundred per c c. In two days the figure reaches 10,500. In three days, 67,000. In four days, 315,000. And on the fifth day there were more than half a million of microbia per c.c."

It would appear from Dr. Leone's further experiments, that the fact of the water being at rest merely has no influence on the multiplication of the microbia. The water was agitated by means of a wheel arrangement, and the same results were obtained. It is further to be noted that, after attaining the maximum, the number of microbia gradually declined, so that a curve would be given by a graphic illustration.

The results obtained by Dr. Smith from his hydrogen test, and by cultivation in gelatin, were approximately the same. *Prima facie*, however, it seems obvious that these results would be affected by the length of time which might have elapsed subsequent to the collection of the samples. We must assume, of course, that multiplication would take place in the spring or stream as in the test-vessels; but the water under natural conditions would be constantly diluted from the source, so that the proportion might never rise much above the minimum. In the test-vessels all the succeeding generations would be retained in the confined space. It seems obvious, therefore, that the comparisons would be affected by the factor of time. Water tested immediately after collection at the spring would apparently give smaller indications of microbe activity than if retained for twenty-four hours or longer. Much, too, would depend on whether the testing took place after the maximum reproduction had been attained, and the curve had taken a downward course.

Dr. Leone experimented also with water saturated with carbonic acid under pressure, and records the result as follows:—"In these researches it was found that whilst in the non-carbonic water the number of microbia rose in five, ten, and fifteen days from hundreds to thousands per c.c., in the carbonic water the number of microbia not only did not increase but it diminished. In five days the number of organisms had fallen from 186 per c.c. to 87; in ten days to 30; and in fifteen days to 20."

Dr. Leone applied other tests and came to the conclusion that the carbonic acid is the sole agent which interferes with the life of organisms in carbonic waters.

One or two inquiries suggest themselves to me in connection with these very interesting observations. In the first place can we safely accept the mere numbers of the microbia as an expression of their chemical activity? Thus, taking Dr. Smith's hydrogen test, the quantity of hydrogen given off is regarded as an indication of the relative impurity of the water. But would a greater evolution of hydrogen be necessarily associated with a greater number of microbia? Pasteur has called attention to a remarkable peculiarity in the life-history of microbia, observed during his experiments with the beer ferment. In the case of all other living creatures the weight of nutritive matter assimilated is proportionate to the weight of food consumed. In the case of alcoholic fermentations, however, the quantity of yeast formed is not proportionate to the quantity of sugar decomposed, but varies according to other conditions, noticeably the abundance of free oxygen. Thus for *a* of yeast formed the weight of sugar decomposed in the process may be 10*a*, 20*a*, 100*a*, or even more. Much depends in this respect. M. Pasteur argues, upon whether the yeast—or the microbe—has the vigour of youth or the decrepitude of senility. The cells of yeast, he tells us, in order to multiply in a fermentable medium in the absence of free oxygen, must be young and full of life and health; if older, they have much difficulty in reproducing themselves in a *milieu* deprived of free oxygen. For the reasons already given, therefore, it would appear that the mere quantity of microbia reproduced in a given time may not be a test of the relatively innocuous character of the water or of the chemical activity of the organisms present. The quantity of hydrogen given off would apparently be a test of the latter, and it seems not improbable that, at least in some cases, the pathogenic virulence of microbia may be proportionate to the chemical activity set up rather than to the productive activity. The inquiry suggests what is, to me, a rather startling thought, and that is whether we may not arrive at a method of treating zymotic diseases by actually feeding the specific microbia, or, in other words, supplying them with appropriate means

of existence, and thus diminishing their pathologically destructive action. If we follow out this line of reasoning it does not appear to follow necessarily that because, according to Dr. Leone, carbonic acid interferes with the life of organisms in water, or, in other words, arrests their multiplication, therefore it is a hygienic agent. Much must depend on the character of the organisms. Such a condition may simply eliminate the weaker or older organisms, and even accumulate their vital energy in those which remain. In dealing with this mysterious field of research, where there is still so much to tempt the investigator, I may, I hope, be pardoned for asking whether under certain circumstances a quantitative diminution of the microbia may not be consistent with a qualitative increase in regard to the capacity of the remainder for work?

NOTICES OF BOOKS.

The Artists' Manual of Pigments: showing their Composition, Conditions of Permanency, Non-Permanency, and Adulterations; Effects in Combination with Each Other and with Vehicles; and the most reliable Tests of Purity. By H. C. Standage. London: Crosby Lockwood and Co.

The artist, like the dyer or tissue-printer, should be a chemist. He has to be well acquainted with the nature of colouring-matters, their behaviour with air and light, with each other, and with the mediums or vehicles employed. If he neglects these questions, then, however admirable may be his works, both in conception and execution, they will prove fugitive, and posterity, gazing at some discoloured picture, will turn away disappointed. Mr. Standage refers, in his Preface, to the deterioration of the hues of modern paintings, and especially English paintings, in comparison with the worke of the old masters. This change for the worse, this progress in the wrong direction, he ascribes to "the ignorance of the modern artist as regards the actual nature of the materials he employs." Strange and sad that, in spite of the development and the diffusion of chemical knowledge, our modern artists should have a less practical acquaintance with colours than had their predecessors. He thinks that the supply of ill-made and adulterated pigments is greatly encouraged by the "huge host of amateur painters and manufacturers of 'pot-boilers' who have no name to lose by bad workmanship."

Mr. Standage begins his survey of colours with baryta-white, known also as constant or permanent white, or as "blanc fixe." This compound, he tells us, "consists of 137 equivalents of barium, 32 equivalents of sulphur, and 64 equivalents of oxygen." This is a misuse of the term equivalent. Barium sulphate consists of 1 atom of barium, 4 atoms of oxygen, and 1 atom of sulphur, or 137 parts by weight—not equivalents—of barium, 64 of oxygen, and 32 of sulphur. For the detection of free sulphuric acid in barium sulphate—a perfectly unpardonable impurity—he recommends to "add a few fragments of loaf-sugar to a largely diluted solution (?) of the pigment, and evaporate to dryness. A black charred residue indicates free sulphuric acid." A simpler process is to stir up with distilled water, and to test with blue litmus. If there is the slightest reddening the sample ought to be rejected.

Sap-green, it appears, is adulterated with the extract of raw coffee-berries (caffeo-viridic acid),—a good colour for confectionery, but worthless either for the painter or the dyer.

Guignet's green is described as the best and most permanent green of the palette, which is unaffected by light, damp, or impure air, and is neither injured by nor injures other pigments.

We find it stated that certain colours are injured by darkness. This curious fact can be explained only by the circumstance that they are liable to spontaneous decompositions which light prevents or retards.

Under "Cæruleum" we find what is most probably a clerical error. It is said to be a "stannate of cobalt," artificially made of "carbonate of copper 15 parts, powdered flint 20 parts, and copper 3." This mixture contains neither tin nor cobalt, and must yield a copper silicate.

Under "Indigo" we read:—"The best indigo will swim upon water, and is lightest, brightest, and most copper-coloured, and most fine grain and inodorous." Heavy indigoes are assuredly bad, but light ones may be poor if they have been sophisticated with starch, or if the colouring-matter is poorly developed.

Under "Carmine Lake" the author forgets that it may be adulterated with a lake of aniline scarlet, which dissolves in dilute ammonia, as does the genuine colour.

The chapter on the "Chemical Reactions between two or more Pigments, or between Pigment and Vehicle," is calculated to prove of great use to artists. Certain pigments, safe and permanent *per se*, become fugitive and work mischief if mixed together. Mr. Standage is not at all too rigorous in viewing all lead pigments with distrust.

Ammoniacal fumes are justly mentioned as destructive to paintings, and those of coal-gas—*i.e.*, sulphurous acid passing into sulphuric acid at the expense of atmospheric moisture—should not be forgotten. A picture has a much poorer prospect of long life in the atmosphere of London than it would have had in that of ancient Athens or mediæval Florence.

Space does not allow us to extend our remarks on this useful little book any further. We must say, however, that we are not gratified to find a string of "Examination Questions" as set by the Science and Art Department.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cii., No. 7, February 15, 1886.

Death of the Perpetual Secretary M. Jules Jamin.—This issue opens with the discourses pronounced at the funeral of this distinguished physicist by MM. J. Bertrand and L. Troost.

Electrolysis of Salts.—Adolphe Renard.—In dilute solutions the quantity of metal precipitated increases proportionally to the temperature. If the distance between the electrodes is successively doubled the quantity of metal precipitated decreases in a geometrical progression. From the results obtained it appears that when the two electrodes are identical the quantities of the metal precipitated are proportional to their diameters, and consequently to the square root of their surfaces.

Observations on a Memoir by M. A. Millot on the "Oxidation-Products of Charcoal by the Electrolysis of an Ammoniacal Solution."—A. Bartoli and G. Papasogli.—M. Millot affirmed in a memoir (*Comptes Rendus*, Aug. 10, 1885) that no mellic acid was found in the ammoniacal solution electrolysed. The authors reply that if he failed to find mellic acid in the ammoniacal liquid and mellogen in the black matter he must have experimented under different conditions from them.

A Compound of Acetic Ether and Magnesium Chloride.—J. Allain-le-Canu.—Acetic ether forms a definite compound with magnesium chloride just as it does with calcium chloride, but the desiccation of the crystals formed is in the former case still more difficu

Strontium and barium chlorides are absolutely insoluble in acetic ether. Zinc chloride dissolves freely with a great liberation of heat.

The γ-Bromo- and Iodo-butyric Acids.—L. Henry.—The γ-bromo-butyric acid crystallises in rhomboidal plates or tablets perfectly white and permanent in the air. It is more soluble in water than the corresponding iodo-compound and dissolves easily in ether and carbon disulphide. It melts at 32° to 33°. The γ-iodo-butyric acid forms crystalline lamellæ, which turn yellow on exposure to the air and melt at 40° to 41°.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. xix., No. 1.

Ortho-nitroglycines and their Reduction Products.—J. Plöchl.—An account of ortho-nitro-phenylglycine, oxydihydro-quinoxaline, ortho-nitro-tolylglycine, and oxydihydro-toluquinoxaline.

Contributions to the Knowledge of Carvacrol and its Derivatives.—S. Lustig.—Carvacrol (oxycymol) occurs præ-formed in the ethereal oil of *Satureia hortensis* and in the oils of origanum. To a small extent it is found in the oil of *Thymus serpyllum* along with its isomer thymol. The author discusses carvacrol-sodium, ethyl- and benzoyl-carvacrols, acetyl-carvacrol, the action of chloroform and sodium hydroxide in aqueous solution upon carvacrol, and the oxidation of carvacrotin-aldehyd by potassium permanganate.

Action of Carbon Oxychloride upon Copper Acet-acetic Ester.—MM. Conrad and Guthzeit.—Not adapted for useful abstraction.

New Quinon-derivatives from Succinylosuccinic Ether.—A. Hantzsch and K. Loewy.—The author has obtained and examined dioxyquinon-dicarbonic ether and its derivatives.

Ammonium Derivatiues of the Acid Ethers of Pyridin and Quinoline.—A. Hantzsch.—.—In contrast to the ammonium compounds of all the pyridin-carbonic ethers hitherto examined, which are readily saponifiable, the chlor- or iod-methylate of this quinoline-carbonic ether energetically resists this action. Nor was it possible to split up the ammonium base by strong sulphuric or hydrochloric acid into acetic acid and methyl-pseudo-carbostyril. It remains either undecomposed or yields humoid products.

Action of Acetophenon upon Ammonia.—C. Engler and P. Riehm.—The authors obtain by this reaction a base which is a pyridin derivative.

Action of Chlorolevulic Ester upon Sodium-malonic Ester.—MM. Conrad and Guthzeit.—The product of this reaction is α-carboxyl-β-acetyl-glutaric acid. The authors have examined the zinc, barium, and silver salts of this nsw compound.

Ammonia as a Reagent for Double Ketones of the Position 1 : 4.—L. Knorr.—The author dissolves a small portion of the substance in question in glacial acetic acid, adds a solution of ammonia in an excess of acetic acid, boils the mixture for half a minute, adds dilute sulphuric acid and boils again, introducing a splinter of pine wood into the solution. An intense reddening of the splinter shows the presence of a double ketone of the position 1 : 4.

On Glucosamine.—F. Tiemann.—The author has obtained phenylglucosazon from glucosamine hydrochlorate, examined glucosamine hydrobromate, and determined the specific rotatory power of glucosamine hydrochlorate.

Action of Hypochlorous Acid upon Chinoline Derivatives.—Alfred Einhorn and R. Lauch.—If chinolin is added to a clear filtered solution of hypochlorous acid, obtained by mixing an aqueous solution of chloride of lime with an excess of boric acid, there is a considerable development of heat, which is moderated by refrigeration. Basic calcium borate is deposited, and in the resinous mass resulting from the reaction there occurs carbostyril along with unchanged chinolin.

On the Isomeric α-Naphthylamin Sulpho-acids. Otto N. Witt.—The author describes Piria's naphthionic acid and has obtained its copper salt (the existence of which was questioned by Piria) as a white crystalline salt. He then describes the acid of Nevile and Winther, which he finds to be a homogenous compound. Lastly he has prepared and examined an acid by the reaction of naphthylamine and an excess of sulphuric acid.

On Wrightine.—H. Warnecke.—This alkaloid, first isolated by Stenhouse in 1861, from the seeds of *Wrightia antidysenterica*, an apocynaceous tree from India. It is the first-known solid base occurring in nature which is free from oxygen. If a trace of this base, dissolved in chloroform, is evaporated to dryness in a porcelain capsule, the residue covered with 2 to 3 c.c. of water, and strong sulphuric acid is added in a slender stream, a golden-yellow colour spreads from the bottom of the capsule through the whole liquid, and turns to a green on standing for 12 hours. If 1 m.g. of the alkaloid is rubbed up in a watch-glass with 5 drops of strong sulphuric acid and let stand exposed to the air for 2 hours, the liquid, which was at first colourless, turns yellowish-green, and finally a pale violet. It the above mixture is at once exposed in the neck of a flask to the steam of boiling water the mass turns dark green, and passes into deep blue on contact with a little water.

Bulletin de la Société Chimique de Paris. Vol. xlv., No. 4, February 20, 1886.

Essays on Fatty Matters: Cacao Butter.—Ch. Du Bois and L. Padé.—Cacao butter melts at 26·8° after an hour's solidification, at 27·4° after 24 hours, at 30·2° after 48 hours, and at 32° after 72 hours. This last point varies no more after a month. The mean density of cacao butter at 18° is 0·980.

Reclamation of Priority on Dioxy-ethyl-methylene.—W. H. Greene.—The author described the properties of this compound some years ago (*Comptes Rendus*, lxxxix., p. 1007). M. L. Pratesi re-discovered the same compound in 1883 (*Gaz. Chim. Ital.*, xiii., p. 313). Quite recently M. Louis Henry has announced (*Comptes Rendus*, ci., p. 599) the preparation of biethyl-oxylated methane by the reaction of sodium ethylate upon methylene iodide, but the density which he ascribes to this body (0·8275) and the boiling-point (82° to 83°) seem to indicate that the compound which he obtained was not pure.

On a New Synthesis of an Inactive Borneol.—G. Bouchardat and J. Lafont.—Already noticed.

Transformation of Oil of Turpentine into Active Terpilene.—G. Bouchardat and J. Lafont.—Already noticed.

Determination of Chrome.—H. Vidal.—Reserved for insertion in full.

Russian Chemical Society.—Session Dec. 13/27, 1884.

N. Menschoutkine made a communication on the isomerism of the hydrocarbons according to the theory of substitutions.

F. Bevade sent in a research on the precipitation of the carbonates of the earthy alkaline metals by the alkaline carbonates, with reference to the duration of the reaction, to the masses, and to the nature of the bodies brought into contact.

N. Socoloff presented the results of his analyses of the water of the Neva during 1883-84.

V. Alexeeff pointed out, with reference to the isomerism of solutions, that the presence of a point of transition in these phenomena could only be explained by admitting that bodies might be dissolved either whilst remaining in the solid state, or whilst passing previously into the liquid state.

M. Pospekhoff had studied the reduction-products of nitrocumine, obtaining yellow azocumine, fusible at 112° to 113°, and then becoming volatilised, and hydrazocumine, colourless and melting at 65°.

M. Volodkevitch observed, on heating β-naphthylamine with lead oxide, the formation of crystalline needles, apparently Dehr's azonaphthaline.

P. Alexeeff has studied the action of light upon nitrocuminic acid, which he thinks is by this agency transformed into a true colouring-matter.

E. Wroblewski remarked that the decomposition of the diazo-compounds by alcohol, followed by the formation of the corresponding ethers of the phenols, was indicated in his memoir published in the *Zeitschrift für Chemie*, (new series, vol. vi., p. 164).

G. Wachtel explained the results of his study on the manufacture of potassium dichromate.

MM. Gorboff and Kessler exhibited an apparatus for fractionated distillations at low pressures.

J. Barzilowsky sent in remarks on the oxidation of the aromatic amines.

Session January 3/15, 1885.

M. Butleroff made some remarks on Menschutkin's memoir concerning the isomerism of the hydrocarbides according to the theory of substitutions.

G. Gustavson communicated thermic data for the combinations of aluminium bromide with the hydrocarbons.

M. Pavloff brought forward facts serving to establish the empirical composition and the molecular formula of tetric acid.

M. Chechoukoff described a method of separating the butylenes prepared according to the method of Puchot.

M. Alexeeff has studied the vapour tension of solutions with a view of determining the relations between the composition of these vapours, their tension, and their other properties.

The first number of the Society's *Journal* contains also memoirs "On the Preparation of Hemine," by M. Schalfeeff; "On the Crystalline Form of Hemine," by M. Legorio; "On Diallyl," by A. Sabaneeff; and "On Heptanaphthene," by P. Milkowsky.

Session February 7/19, 1885.

A. Krakau mentioned some accuracies in the deduction of the number of the isomeric derivatives of the benzol series, according to the theory of substitutions.

M. Menschutkine proposed an examination in detail of these remarks.

M. Kaiander presented a remark concerning Menschutkine's memoir on the isomerism of substitutions.

M. Butleroff read a memoir on chemical structure and the theory of substitutions.

M. Menschutkine answered, promising to return to this question.

M. Mendelejeff summed up briefly the history of the question under discussion. He pointed out the want of precision from the mechanical point of view of the distinction between the atomic bonds and the influence of the elementary atoms upon each other, and discussed finally the question of the atomicity of the elements.

The second part of the Society's Journal contained further a memoir, by E. Schatzky, on diallyloxalic acid.

Swedish Correspondence.—By P. T. Cleve.—This correspondence contains a paper, by K. Arnell, on the action of sulphuric acid upon monochlorised naphthaline; a memoir, by J. E. Alen, on α-oxazonaphthaline α-sulphurous acid; a paper, by J. A. Bladin, on the action of cyanogen upon phenyl-hydrazine, which will be inserted in full; a paper, by P. T. Cleve, on the action of benzaldehyde upon hydrazobenzol, in which there is formation of azobenzol, the hydrazobenzol thus appearing to act as a reducing agent. On adding to the mixture zinc chloride, benzylidene-benzidine is produced.

On Platoso-oxalic Acid.—H. G. Söderbaun.—This memoir will be found inserted in full.

MEETINGS FOR THE WEEK.

MONDAY, March 8.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Petroleum and its Products," by Boverton Redwood, F.C.S.
TUESDAY, 9th.—Institution of Civil Engineers, 8
—— Royal Medical and Chirurgical, 8.
—— Photographic, 8.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
WEDNESDAY, 10th.—Society of Arts, 8. "The Experiments with Lighthouse Illuminants at the South Foreland," by E. Price Edwards.
—— Geological, 8.
—— Pharmaceutical, 8.
—— Microscopical, 8.
THURSDAY, 11th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— London Institution 7.
—— Royal Institution, 3. "The Ancient Geography of Britain," by Prof. W. Boyd Dawkins, F.R.S.
—— Society of Arts, 8. "Films and Paper as Substitutes for Glass in Photography," by Leon Warnerke.
—— Mathematical, 8.
FRIDAY, 12th.—Royal Institution, 9. "The Discovery of the Biblica Cities of Egypt," by R. S. Poole, LL.D.
—— Astronomical, 8.
—— Quekett Club, 8.
SATURDAY, 13th.—Royal Institution, 3. "The Nature and Protective Use of Colour in Caterpillars," by Edward B. Poulton, M.A.
—— Physical, 3. "On the Growth of Filiform Silver," Dr. Gladstone, F.R.S "Apparatus for Measuring the Electrical Resistance of Liquids," Professor Reinold, F.R.S.

TO CORRESPONDENTS.

Baxter Davenant.—You should refer to a good work on "Soap Making." See the one by A. Wall reviewed in our columns (vol. lii., p. 199, No. 1351).

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THE CHEMICAL NEWS.

VOL. LIII. No. 1372.

COLOUR PHOTOMETRY.*

By Captain ABNEY, R.E., F.R.S., and Major-General FESTING, R.E.

ONE of the authors of this paper has already communicated to the Physical Society of London (*Phil. Mag.*, 1885) a method by which a patch of monochromatic light could be thrown on a screen. This formed the starting point of the present investigation, which was to ascertain whether it was practicable to compare with each other the intensity of lights of different colours.

The authors describe various plans they adopted to effect this purpose, and finally found that by placing a rod in front of the patch of monochromatic light, and of a candle by casting another shadow, the intensities of the two lights could be compared by what they term an oscillation method. It is known that on each side of the yellow of the spectrum the luminosity more or less rapidly decreases. By placing a candle at such a distance from the screen that the luminosity of the two shadows appears as approximately equal, it is easy to oscillate the card carrying the slit through which the monochromatic rays of the spectrum pass. (The slit is in the focus of the lens which helps to form the spectrum.) The shadow of the rod cast by the candle can thus be made to appear alternately "too light" or "too dark" in comparison with the shadow of the rod cast by the parts of the spectrum falling on the screen. By a rapid oscillation the position of equality of the two shadows can be distinguished with great exactness. The authors describe their method of fixing the position of the rays employed and the source of light with which the spectrum is formed. They also enter into details as to the comparison light, the receiving screen, and the comparative value of the light as seen by them respectively. The curve of the intensity of the arc light spectrum, as seen by their eyes, which they call the normal curve, is then described. The question as to the effect of an alteration of the colour of the comparison light is then discussed, as is the effect of the brightness of the spectrum.

The next point touched upon is as to the value of mixed light as compared with its components. It is found that the following law holds good, viz.: *that "the sum of the intensities of two or more colours is equal to the intensity of the same rays when mixed."* This law is applied to Hering's theory of colour.

The authors next state that with the majority of people the curve of luminosity of the spectrum is identical with the normal curve, but that in some cases slight differences may be observed, of which one example is given. Such slight deficiency does not constitute colour-blindness, since the want of appreciation of any colour is but very partial. They next describe observations made by four colour-blind persons, and show that there is a remarkable divergence in their curves from the normal. The deficiency curves are shown, from which it appears that two of the observers are totally blind to red, whilst the other two are partially so. They then show that such observers would not give a true value for any light which is not of identically the same colour as the comparison light they might employ. It also appears that the intensity of illumination felt by a colour-blind is really less than that perceived by a normal-eyed person.

Two examples of the normal curve for sunlight are then given, one taken on a day in July by the method of separating close lines by means of varying illumination, and the other in November, by the method adopted by the authors. Their results are compared with Vierordt's curve, obtained by extinguishing colour with white light.

In order to ascertain the effect of the turbidity of a medium through which light passes (for instance sunlight) the authors compared the intensity of the spectrum after passing through clear water and turbid water, and found that the absorption agreed with Lord Rayleigh's theoretical deductions that $I' = I_0 \varepsilon^{-kx\lambda^{-4}}$, where I' is the intensity after passing through a turbid medium, I_0 the intensity after passing through clear water, x the thickness of the turbid layer, k a constant independent of λ, λ being the wave length.

The authors conclude their paper with a discussion of the intensity of incandescence of carbon electrically heated.

* Abstract of the Bakerian Lecture delivered before the Royal Society March 4, 1886.

ON THE EQUIVALENT OF THE TERBIUMS.

By M. LECOQ DE BOISBAUDRAN.

IT has not yet been found practicable to separate completely from terbia all the other known earths. These latter are always present in very notable quantity, and often form the major part of the total mass. Consequently the equivalents found for various specimens of terbia vary considerably.

Prolonged fractionations, effected at first with ammonia and then with potassium sulphate, have enabled the author to prepare a yellow earth very perceptibly darker than any of those which he has had the opportunity of seeing previously.* This deep-coloured body contains mere insignificant traces of the foreign bodies formerly known, except holmium, the proportion of which, however, is small. We cannot, however, regard this earth as homogeneous, even if we disregard its small admixture of holmium, for it gives very fine spectra of $Z\alpha$ and $Z\gamma$ (the non-identity of which is not demonstrated), which do not seem to belong to the deep earth, since they are more developed at the opposite extremity of the fractionation by potassium sulphate where the oxides are much less coloured. As for the fluorescence $Z\beta$, as it is most brilliant in the deepest coloured earth, we cannot affirm that it indicates the presence of a heterogeneous element. The question of the identity of $Z\beta$ and of Tr remains, therefore, open, but the author observes that this fluorescence, $Z\beta$, is still very fine with earths but slightly coloured.

The equivalent of the deep-coloured earth (composed of $Z\beta$-Tr, $Z\alpha$-$Z\gamma$, and a small quantity of Ho with traces of erbium and samarium) is a little higher than those of the various terbiums prepared by the authors whose memoirs M. de Boisbaudran has been able to consult.

It must be remarked that all the former specimens of terbia which the author has been able to examine spectrally contain large proportions of the $Y\alpha$ of M. de Marignac, and of holmium and also of yttrium and samarium. The equivalents of $Y\alpha$, Sm, and especially of Yt, being relatively low, have naturally tended to reduce the equivalents of the terbiums containing these bodies.

The equivalents have been determined by the method of anhydrous sulphates. Each value is the mean of several fairly concordant numbers. The experiments have been made upon portions of the earth varying from 0·2 to 0·7 grm. for the equivalents, and upon 0·04 to 0·06 grm. for the determination of the oxygen in excess over formula M_2O_3.

The author's darkest earth has a superoxidation rather variable (like its colour) according to the manner in which

* The author here adds the following note:—M. Delafontaine announces that he has prepared a deep orange-yellow terbia, but the equivalent of this earth was 114, a value which he considers as a minimum.

	No. I. Impure Terbia from Gadolinite. Equiv. = 115.	No. II. Terbia from Samarskite. Equiv. = 122·3.	No. III. Terbia prepared by M. Clève. Equiv. = 117·7.	No. IV. Author's palest Terbia. Equiv. = 123·6 minimum.	No. V. Author's darkest Terbia. Equiv. = 124·7 minimum.	
Colour of earths.	Very pale.	Medium, darker than No. I.	Tolerably dark.	Pale, a little paler than No. I.	Dark.	
Absorption.	Decided.	Decided.	Decided.	Much more than in No. V.	Very slight.	Ho.
	Very distinct, but much less abundant than Ho.	Slight, but more than in III. and V.	Slight traces.	Moderate, but much more than No. V.	Very slight traces.	Er.
	Slight.	Nil.	Distinct.	Nil.	Very slight traces.	Sm.
	Very slight.	Nil.	Nil, or very slight.	Nil.	Nil.	Di.
Direct spark. Hydrochloric solns.	Distinct.	Nil.	Nil.	Slight traces.	Nil.	Yt.
	Strong, rather more than No. 2.	Very distinct, more than No. III.	Very distinct.	Nil.	Nil.	Yα.
	Very distinct, but less than No. II.	Very distinct.	Not determined.	Very distinct, more than No. V.	Very distinct.	Zγ.
Fluorescences of the hydrochloric solns.	Very distinct, slighter than in No. II., but not sufficiently determined.	Distinct, but not sufficiently determined.	Very moderate, but insufficiently determined.	Strong, decidedly more than is No. V.	Very distinct.	Zα.
	Strong.	Strong.	Strong, but rather less than in No. IV.	Strong, but decidedly less than No. V.	Very strong.	Zβ.

the calcination has been effected. This superoxidation in the samples employed for determining the equivalents has been found from 0·71 to 0·69 per cent of the earth, or in the mean 0·70 per cent.

Deducting this excess of oxygen from the weight of the crude earth we arrive at the following equivalents for the earth of the formula M_2O_3 ($M\frac{4}{3}O$):—

Darkest earth, equiv. = 125·2. In conditions where the number obtained was certainly a maximum.

Darkest earth, equiv. = 124·7. In conditions where the number obtained was probably a little too low.

This would bring the mean atomic weight of the metals of the darkest earth to at least 163·1.

For other terbias, rather less deeply coloured than the author's, we have:—

Terbia from gadolinite, still impure 115
" " samarskite .. .. 122·3
" " an unknown source, prepared by M. Clève .. .. 117·7

The author's palest earth (fractionated by potassium sulphate) gave an excess of 0·12 to 0·16 in excess above M_2O_3, or as a mean 0·14 per cent, deducting this oxygen from the weight of the crude earth, we have the equivalents:—

Palest earth, equiv. = 124·1. Number certainly a maximum.

Palest earth, equiv. = 123·6. Number probably a little too low.

This would bring the mean atomic weight of the metals of the palest earth to at least 161·4.

The Table above is the result of spectral analysis applied to the various terbias.

The author adds in a note that the terbia No. III. had been placed in his hands for spectroscopic examination but had been returned to M. Clève. He has, therefore, not been able to compare directly the fluorescence of the terbia No. III. with the fluorescences of his more recent products, which would have been necessary for the exact determination of the relative intensity of these spectra. This terbia of M. Clève's, though still containing in particular holmium, samarium, and Yα is still freer from foreign matters already known than any specimen examined prior to the preparation of the dark-coloured earth No. V. Still its equivalent is very low and corresponds only to a mean atomic weight of 152·5.—*Comptes Rendus* (cii., p. 395).

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

(Continued from p. 111.)

Influence of different percentages of Sodium Carbonate on the Diastatic Action of Saliva.

In 1882, while studying the influence of peptones on the diastatic action of alkaline saliva,† data where then obtained showing a constant diminution of diastatic action in the presence of the alkaline carbonate: the conversion of starch into sugar being diminished in proportion as the percentage of alkali was increased. The digestions at 40° C. were then continued for 45 minutes and the ptyalin was present in large amount, 25 of the 100 c.c. of digestive mixture being undiluted, unneutralised saliva, thus making a very powerful diastatic fluid. We give the data then obtained in the percentage of starch or glycogen converted into sugar.

a. Influence of 0·05 per cent Sodium Carbonate.

	Saliva alone.	Saliva + Na_2Co_3 = 0·15 p.c.	Difference.
Glycogen	28·68 p.c.	20·20 p.c.	8·48 p.c.

b. Influence of 0·15 per cent Sodium Carbonate.‡

	Saliva alone.	Saliva + Na_2Co_3 = 0·05 p.c.	Difference.
Starch ..	40·23 p.c.	17·48 p.c.	22·75 p.c.
" ..	37·15	14·72	22·43
" ..	37·55	15·48	22·07
" ..	38·36	13·57	24·79
Glycogen	28·68	9·40	

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.
† Chittenden and Ely, *Amer. Chem. Jour.*, iv., 121.
‡ The alkalinity is somewhat greater, owing to the unneutralised alkali of the saliva.

c. Influence of 0·30 per cent Sodium Carbonate.

	Saliva alone.	Saliva + Na_2Co_3 = 0·30 p.c.	Difference.
Starch ..	40·27 p.c.	10·83 p.c.	29·44 p.c.
„ ..	40·23	9·87	30·36
„ ..	37·15	9·52	27·63
„ ..	38·80	9·79	29·01
„ ..	37·55	10 01	27·54
„ ..	38·36	9·60	28·76
Glycogen	29·11	6·93	

The action of the sodium carbonate is here very marked and very constant.

We have repeated this series of experiments in part, varying the conditions only by using neutralised saliva, so that the percentages of alkali present might be exact.*

SERIES VIII.

Per cent Na_2Co_3.	Starch converted.	Difference.
0	41·16 per cent.	
0·005	39·47	1·69 per cent
0·025	34·84	6·32
0·050	29·81	11·35
0·150	17·88	23·28
0·300	10·88	30·28

It is evident from these results that the presence of a definite percentage of sodium carbonate will produce approximately a constant diminution in the diastatic action of the saliva. This result, however, is constant only when the saliva acts in the above dilution. Diminish the amount of ferment—or rather dilute the saliva—and then the above percentages of alkali produce quite a different result. The above results were obtained where the dilution of the saliva was as 1 : 4. Adding now neutralised saliva to the alkaline mixtures of starch and water in such proportion that 10 c.c. of the original saliva are present in 100 c.c of digestive mixture, *i.e.*, a dilution of 1 : 10, the results are different.

The following figures were obtained with the above dilution, the mixtures being warmed at 40° C. for 30 minutes.

SERIES IX.

Per cent Na_2Co_3.	Wt. Cu in one-eighth.	Total amt. sugar formed.
0	0·0998 grm.	0·4064 grm.
0·005	0·0898	0·3664
0·025	0·0437	0·1816
0·050	0·0277	0·1184
0·100	0·0182	0·0808
0·300	0·0105	0·0504
0·500	0·0091	0·0448

These figures lead to the following percentages of starch converted into sugar under the different degrees of alkalinity.

Per cent Na_2Co_3.	Starch converted.	Difference.
0	36·57 per cent	
0·005	32·98	3·59 per cent.
0·025	16·35	20·22
0·050	10·66	25·91
0·100	7·27	29·30
0·300	4·53	32·04
0·500	4·03	32·54

By comparing the two preceding columns of differences it is very manifest that the alkaline carbonate has a much greater retarding action on the more dilute saliva than on the stronger solution; very noticeably so in the mixtures containing 0·025 and 0·050 per cent of the alkaline salt.

By diluting neutralised saliva still more, and then using quantities of the fluid equal to 2 c.c. of the original saliva, making in the 100 c.c. of digestive mixture a dilution of 1 : 50, even 0·005 per cent of sodium carbonate is sufficient to retard the diastatic action of the ferment almost completely; thus, in one experiment with the above amount of saliva in the presence of 0·005 per cent sodium carbonate but 4·03 per cent of the starch was converted into sugar in 30 minutes at 40° C., while the same amount of saliva alone converted 27·08 per cent of the starch into sugar. By increasing the percentage of alkaline carbonate the diastatic action was stopped completely.

It it thus evident that the percentage of alkaline carbonate which absolutely or to a certain extent hinders the diastatic action of saliva can be designated only for a definite mixture, and not in a general sense. Langley and Eve* state that sodium carbonate of 0·0015 per cent causes a retardation in the action of ptyalin; our experiments with unneutralised saliva diluted, plainly show that even much smaller percentages of alkalinity may decidedly retard the action of the ferment, while in similarly diluted saliva 0·005 per cent of sodium carbonate may prevent diastatic action almost entirely.

Again Langley and Eve† state that the "amylolytic action of saliva becomes less the more alkaline salt there is in the solution; the rate of decrease is, however, slow compared with that which occurs when hydrochloric ocid is added in similarly increasing quantities." The rate of decrease, however, as our experiments plainly show, is dependent greatly upon the amount of dilution.

Destruction of Salivary Ptyalin by Sodium Carbonate.

To how great an extent is the retarding influence of sodium carbonate due to destruction of the ferment?

Langley and Eves‡ state that "sodium carbonate has a very slight destructive action on ptyalin, its retarding power is out of all proportion to its power of destruction."

The following experiments demonstrate the exact action of the sodium carbonate.

SERIES X.

70 c.c. of filtered saliva (the same saliva as used in Series IX.), were exactly neutralised with 0·2 per cent HCl and diluted to 140 c.c.

The following mixtures were then prepared:—

	1. C.c.	2. C.c.	3. C.c.	4. C.c.	5. C.c.
Diluted saliva	20	20	20	20	20
Na_2CO_3 sol...	0	20 0·1%	10 0·6%	20 0·6%	20 1%
H_2O	20	0	10	0	0
P.c. Na_2CO_3	0	0·05	0·15	0·30	0·50

These were warmed at 40° C. for 30 minutes, then neutralised with the amounts of dilute acid given below, water and starch added, and the mixtures again warmed at 40° C. for 30 minutes.

	1. C.c.	2. C.c.	3. C.c.	4. C.c.	5. C.c.
HCl 0·2 per cent..	0	6·88	20·6	41·3	68·8
Starch + H_2O ..	60	53·20	39·4	18·7	20·0
	100	100	100	100	128·8

	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
1.	0·0998 grm.	0·4064 grm.	36·59 per cent.
2.	0·0991	0·4032	36·30
3.	0·0992	0·4040	36·40
4.	0·0474	0·1968	17·71
5.	0·0278	0·1192	10·73

In the above digestive mixtures the ultimate dilution of the saliva is the same as in Series IX., 1 : 10, and being the same saliva, the above results are directly comparable with those of Series IX. Warming saliva of the above strength with 0·05 and 0·15 per cent sodium carbonate for 30 minutes causes no destruction of the ptyalin whatever, as the results of experiments 2 and 3 indicate,

* The standard solutions of sodium carbonate were made from the chemically pure anhydrous salt.

* *Journal of Physiology*, vol. iv., No. 1.
† *Ibid.*
‡ *Ibid.*

consequently any diminished diastatic action in the presence of the above percentages of alkaline carbonate must be due to a simple retardation of the action of the ferment and not to its destruction. On the other hand, 0·3 and 0·5 per cent sodium carbonate under like conditions and with the same strength of saliva cause a marked destruction of the ferment, as the results of experiments 4 and 5 plainly show.

We have repeated the above series of experiments with a saliva, neutralised and diluted five times, using in each experiment 10 c.c. of the diluted fluid, equal to 2 c.c. of the original saliva. The only other deviation from the conditions already given consisted in warming the saliva with the alkaline carbonate for 1 hour instead of 30 minutes. We will not give the details of the experiment, as the results were mostly negative. With this amount of saliva, 0·15 per cent sodium carbonate almost completely destroyed the ferment in 1 hour's warming at 40° C., and even 0·05 per cent of the alkaline carbonate showed under these conditions a very great destructive action; thus, after heating the diluted saliva with 0 05 per cent sodium carbonate for 1 hour at 40° C., and then neutralising the mixture, it was able in 30 minutes to convert but 5·69 per cent of starch into sugar, while the same quantity of saliva simply warmed with water converted under like conditions 27·08 per cent of starch into sugar.* Under these circumstances, then, the destructive action of dilute sodium carbonate is very great. To what is due this great difference in the action of sodium carbonate of the same strength? Probably to the presence of the larger amount of albuminous matter which in the less diluted saliva possibly combines with the alkaline carbonate. It would follow, moreover, from our results, that any proteid compound formed has in itself no destructive action on the ferment, even to a slight extent. 0·005 per cent sodium carbonate causes no destruction in the ferment in 1 hour's warming at 40° C.; that is, in saliva of this dilution.

(To be continued.)

GERMANIUM, A NEW METAL.

In the *Derichte der Deutschen Chemischen Gesellschaft* (xix., Part 3) there is an account of a new metallic element discovered by Clemens Winkler. It occurs in argyrodite, a silver-ore from the Himmelsfürst mine, near Freyberg. Germanium, symbol Ge, has a great resemblance to antimony, though it is distinguished by certain well-marked reactions. If the sulphide is heated in the absence of air, *e. g.*, in a current of hydrogen, it forms a blackish crystalline sublimate, which at a higher temperature melts to brownish-red drops. This sulphide dissolves in ammoninm hydrosulphide, and is re-precipitated with a white colour by hydrochloric acid, and is again redissolved by ammonia. If arsenic or antimony is present the colour is yellow. If heated in air, or treated with hot nitric acid, the white germanium oxide is formed, which is not volatile at a red heat. The oxide dissolves in potassium hydroxide. If this solution is slightly acidified it gives a white precipitate on treatment with hydrogen sulphide. The oxide is easily reduced by hydrogen; the sulphide less easily. The metal is grey, volatile at a full red heat, though less readily than antimony. The vapour deposits small crystals resembling those of iodine, which do not melt. In a current of chlorine the metal yields a white chloride which is more volatile than antimony chloride. The acid solution gives a white precipitate with hydrogen sulphide. Herr Winkler is determining its atomic weight with a view to determine its place in the periodic arrangement.

* The amount of destruction produced in saliva of this solution by the above percentage of sodium carbonate does not appear to be constant, since we have found in several cases a much greater diastatic action after an hour's warming at 40° C. than in the above instance, due probably to the larger amount of ptyalin or proteid matter present.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 113.)

On Phosphoric Acid (continued).

(2.) In the Table below are given the average results of the fifteen analyses of "South Carolina" and "Navassa," with the highest and lowest figures reported.

	South Carolina.			Navassa.		
	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.
Soluble P_2O_5—	12·01	12·74	11·59	7·26	8·08	6·40
Reverted P_2O_5—	2·25	2·88	1·75	3·83	5·10	2·92
Available P_2O_5—	14·26	14·78	13·73	11·09	11·82	10·58
Insoluble P_2O_5—	1·28	1·56	0·78	5·93	6·37	5·17
Total P_2O_5—	15·54	16·12	15·09	17·02	17·72	16·31

The most important determinations are those of the available and the total phosphoric acid.

In "South Carolina" we notice a difference of about 1 per cent between the highest and lowest determination of available P_2O_5, or a difference in extreme cases of ½ per cent, from the mean of all results. In "Navassa" the difference between the highest and lowest results on available P_2O_5 is 1½ per cent, or a difference running from 0·7 per cent above the mean to 0·5 below the mean. The differences between the results of the determinations of total P_2O_5 are the same in "South Carolina" and a little larger in "Navassa" than the corresponding differences observed in the results on available P_2O_5.

The question now arises, Is the average results obtained by these fifteen chemists correct? The writer has endeavoured to answer the question, with strong probability, by the following experiments in the case of the total P_2O_5.

The purity of the reagents used and accuracy of manipulation were tested as follows:—

P_2O_5 was determined by ignition as pyrophosphate in a sample of finely pulverised "C. P." hydrogen sodium phosphate, which had been re-crystallised and dried.

The per cent of P_2O_5 was found to be 26·39, 26·43, 26·46, 26·46. Average, 26·43.

P_2O_5 was next determined in the same salt by precipitation with magnesia mixture. The results were 26·43, 26·35, 26·39, 26·42, 26·31. Average, 26·38, or 99 8 per cent.

In the same salt P_2O_5 was also determined by the molybdate method. The results were 26·41, 26·41, 26·31, 26·29, 26·42. Average, 26·37, or 99·8 per cent.

Reagents and manipulation being satisfactory, determinations of total P_2O_5 were made in "South Carolina" and "Navassa" by the molybdate method. The solutions of the phosphates were prepared as follows:—

(A.) Fused from 0·5 to 1 grm. phosphate with 7 grms. sodium carbonate, dissolved the mass in water and HCl, separated SiO_2, and filtered.

(B.) Digested the phosphate (0·6 to 0·5 grm.) with 20 c.c. concentrated HCl, diluted, and filtered.

(C.) Added to the phosphate (0·6 to 0·5 grm.) about 7 c.c. saturated solution of $Mg(NO_3)_2$, evaporated to dryness, and ignited. Dissolved in 20 c.c. concentrated HCl, diluted, and filtered.

(D.) Digested 0·5 grm. with about 2 c.c. oil of vitriol at 100° C. for three to five hours, diluted, boiled residue with strong HCl, and filtered.

A was tried on account of the suggestion of Dr. Shepard that in some cases pyrophosphate may be formed in a

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

phosphate heap, which would not be recovered in the usual method of solution.

D was tried to expel fluorine, which occurs in some phosphates, and is said to impair the accuracy of the molybdate method.

The results are given in the following Table, followed by others contributed by Mr. Clifford Richardson, of the Department of Agriculture :—

	S. Carolina.	Navassa.
A	15·35 15·45	16·96 16·85
B	15·51 15·31	16·80 16·83
C	15·43 15·37	17·00 16·93
D	15·22 15·50	17·00 17·20 16·98
Average	15·39	16·95
Ignited with $Mg(NO_3)_2$; solution in HNO_3	15·48	17·27
Ignited with $Mg(NO_3)_2$; solution in HCl	15·56	17·18
Ignited alone; solution in HCl	(15·59)	(16·87)
Not ignited; solution in HCl	15·26	17·26
Not ignited; solution in HNO_3	15·69	17·31
Average	15·49	17·25
Average of 15 analyses by official and commercial chemists	15·54	17·02

The writer considers the experiments here given as confirming the results obtained by other chemists, simply because they were made under varying conditions, while the others were made presumably under the same conditions.

The results obtained this year leave much to be desired. The samples, it is believed, were as nearly identical as it is possible to make them, and a nearer agreement between chemists on identical samples is necessary and attainable.

The Sub-committee of the Chemical Trades Section of the London Chamber of Commerce (Chemical News, 1884, p. 230) decided that for their uses a difference of less than 1¼ per cent of tricalcium phosphate (equivalent to about 0·7 per cent P_2O_5) was admissible.

If differences of 1¼ per cent or more occurred the analysts concerned were to be requested to explain the discrepancy.

No determinations of available or total P_2O_5 in South Carolina and three in Navassa differ 0·7 per cent from the mean of all results, but as between the highest and lowest figures there are many differences of more than 0·7 per cent. Certainly a chemist who cares for his own reputation and for justice will not let a difference of 0·7 per cent between his own and his neighbour's determination pass without assuring himself by a repetition of his own work and by examination of his reagents that his own result is very nearly correct for the sample on which he worked.

In conclusion your Committee recommends that the methods of analysis adopted at our last meeting be amended as follows :—

Before the "determination of phosphoric acid in fertilisers" insert the following :—

Determination of Moisture in Fertilisers.

(*a.*) In potash salts, nitrate of soda, and sulphate of ammonia, heat 1 to 5 grms. at 130° C. till the weight is constant, and reckon water from the loss.

(*b.*) In all other fertilisers heat 2 grms., or, if the sample is too coarse to secure uniform lots of 2 grms. each, 5 grms. for five hours at 100° in an air-bath.

Your Committee also recommends the following description of the Association's method of determining "citrate insoluble phosphoric acid" :—

The method of extracting "reverted" phosphoric acid was originally designed for and is applicable only to superphosphates, plain or nitrogenised, and was not intended to be applied to rock phosphates, natural guanos, or any other non-acidulated materials to test their relative solubility or availability. In case, however, a determination of citrate insoluble phosphoric acid is required in these non-acidulated goods, it is to be made by treating 2 grms. of the phosphatic material, without previous washing with water, precisely in the way above described, except that in case the substance contains much animal matter (bone, fish, &c.) the residue insoluble in ammonium citrate is to be ignited with magnesium nitrate.

Your Committee further recommends that in all other respects the method adopted at our last meeting for the determination of P_2O_5 in its three states be rigorously followed during the coming year.

They specially urge attention to the following points :—

(1.) The solution of ammonium citrate to be strictly neutral and of the specific gravity indicated.

(2.) Perfect solution of the phosphate in acid. After boiling with acid, diluting, and decanting, it is well to boil the insoluble residue again with strong acid.

(3.) The magnesia mixture to be added not more rapidly than indicated (one drop per second). (Peitsch, Rohn, and Wagner, *Fres. Zeitschr. fur Analyt. Chem.*, xix., 448.)

Since the ignition with $Mg(NO_3)_2$ requires some time and an additional transfer of the material from one vessel to another, which always involves the possibility of mechanical loss, experiments are desirable to determine whether organic matter can be destroyed or made harmless by oxidation in the wet way, by fuming nitric acid or other reagents in the flask in which the subsequent solution of the phosphate is to be made.

It is also desirable to know to what extent silica passes into solution when phosphates of various kinds are digested in strong acid. A single experiment on "South Carolina" gave the writer—

	Per cent.
Total sand and silica	3·92
Brought into solution by boiling in strong HCl	0·02
Brought into solution by ignition with $Mg(No_3)_2$ and solution in strong HCl	0·05

It is also desirable to know what effect silica in solution has on the determination of P_2O_5 by the molybdate method. The testimony on this point is conflicting. (See Bertrand, *Jahresber. Ag. Chem.*, xxvi., 318; Lindo, Chemical News, xxxviii., 1884, 247 *et seq.*; *Bied. Centr. Ag. Chem.*, 1884, 642; Atkinson, *Fres. Zeitschr. f. Anal. Chem.*, xviii., 477; Jenkins, *Journ. f. Prakt. Chem.*, xiii., 237.)

Your Committee also express the belief that an annual distribution of samples and comparison of results will be of great use in securing accuracy and uniformity among analysts, and urge on the members of the Association the desirability of promptly analysing and reporting results on samples which they receive.

All of which is respectfully submited.

E. H. Jenkins, *Chairman.*
H. C. White.
W. C. Stubbs.

Mr. Gladding said a study of the results of the analyses just given, especially those of Dr. Jenkins and Mr. Richardson, shows that while working on acid phosphates made from Charleston and Navassa rock the results were practically identical whether a simple solution in HCl or HNO_3, a fusion with Na_2CO_3, or an ignition with H_2SO_4 were employed. He therefore argued that, as the simplest manipulation was always to be preferred, other things

being equal, the use of magnesium nitrate be omitted in all such cases where it is, without dispute, unnecessary.

Dr. Dabney found the manipulation of the phosphate in a capsule with magnesium nitrate, as laid down in the adopted method, awkward and perilous. Fine cracks form in the capsules which are scarcely to be seen, but which let a little of the concentrated solution leak through at the next step. Like Mr. Gladding, and for these additional reasons, he had not treated simple rock phosphate with magnesium nitrate and ignited, except in making experiments and when the character of the phosphate was uncertain. He hoped the Association would recognise this as sufficient.

Dr. Jenkins said the reason why HCl was adopted by the Association as a solvent for phosphates, instead of HNO_3 was that it more readily and quickly brings them into solution. With care HNO_3 will answer perfectly. During an entire season a comparison was made of the two solvents in his laboratory by different chemists. In the rather small number of cases where there was disagreement the HCl solution invariably gave slightly higher results. It may be claimed that this was due to silica brought into solution by the HCl. Two trials made with reference to this point showed that it dissolved silica very little, if at all. (0·02 and 0·05 per cent silica were dissolved from South Carolina phosphate, which contained 3·92 per cent of sand and silica.) The presence of chlorides, introduced by hydrochloric acid, somewhat retards but does not prevent the precipitation of P_2O_5.

He believes the reduction of P_2O_5 to pyrophosphate during ignition of the insoluble residue from the citrate extraction is slight. He had at hand only the results of a single trial. Three such residues from a superphosphate containing animal matter were ignited directly, three others were fused with sodium carbonate, silica was separated, and P_2O_5 was determined in the six lots. The results were :—

	Average.
Ignited : 2·82, 2·75, 2·91	2·83
Fused : 2·85, 2·96, 3·04	2·95

(To be continued).

THIRD REPORT OF THE COMMITTEE*

RE-APPOINTED FOR THE PURPOSE OF DRAWING UP A STATEMENT OF THE

VARIETIES OF CHEMICAL NAMES WHICH HAVE COME INTO USE,

FOR INDICATING THE CAUSES WHICH HAVE LED TO THEIR ADOPTION, AND FOR CONSIDERING WHAT CAN BE DONE TO BRING ABOUT SOME CONVERGENCE OF THE VIEWS ON CHEMICAL NOMENCLATURE OBTAINING AMONG ENGLISH AND FOREIGN CHEMISTS.†

(Continued from p. 116).

VII.

1. —
2. —
3. —
4. —
5. —
6. Bichromate of chloride of potassium.
7. —
8. Bichromate of chloride of potassium.
9. Bichromate of chloride of potassium ($KCl+2CrO_3$).
10. —
11. —
12. Chromsäure und Chlorkalium ($KCl+2Cr$).
13. Zweifach chromsaure Chlorkalium, chlorchromsaure Kali ($KCl,2CrO_3$ oder $KO,CrO_3.CrO_2Cl$ oder $3(KO.CrO_3)+(CrCl_3.2CrO_3)$.
14. —
15. ($KCl,+2CrO_3$).
16. Bichromate of chloride of potassium ($KCl+2CrO_3$).
17. Bichrômate de chlorure de potassium or chlorochrômate de potasse ($KCl.2CrO^3$).
18. —
19. Zweifach chromsaures Chlorkalium ($KaCl,2CrO_3$).
20. Bichromate of chloride of potassium ($KCl,2CrO_3$).
21. Bichrômate de chlorure de potassium, or chlorochrômate de potasse.
22. —
23. Chromochloride of potassium, 1863. Potassium chromatochloride, 1872. Potassium chlorochromate 1875 and 1879 (KCl,CrO_3).
24. —
25. —
26. —
27. —
28. Bichromate de chlorure de potassium.
29. —
30. —
31. Chlorchromsaures Kali $\left(CrO_2\begin{matrix}Cl\\OK\end{matrix}\right)$.
32. —
33. Dichromate of chloride of potassium, or potassic chlorochromate (KCl,CrO_3 ?).
34. Potassium chlorochromate ($KCrO_3Cl$).
35. —
36. Potassium chorchromate.

VIII.

1. Nitrat of lead.
2. Nitrate of lead.
3. Subnitrate of lead.
4. Subnitrate of lead.
5. Dinitrate of lead.
6. Dinitrate of lead ($2PL+n'$).
7. Nitras biplumbicus ($\dot{\dot{P}}b^2N_2$).
8. Dinitrate of lead ($2PL+n'$).
9. Bibasic nitrate of lead (PbO,NO_5+PbO).
10. —
11. —
12. Basisch salpetersaures Bleioxyd PbN).
13. Zweifach basisch salpetersaures Bleioxyd ($2PbO,NO_5$. or $2PbO,NO_5.HO$).
14. —
15. Basic salt, containing two atoms of oxide of lead united to one of nitric acid.
16. Bibasic nitrate of lead (PbO,NO_5+PbO).
17. Sous azotate de plomb; azotate bibasique ($2PbO.NO^3+HO$).
18. Basic nitrate.
19. Halbsaures Salz (PbO,HO,PbO,NO_5).
20. Dinitrate of lead ($2PbO,NO_5$).
21. (See 17).
22. —
23. Basic nitrates of lead; diplumbic nitrate.
24. Azotate basique de plomb $\left(\dot{P}b''\left\{\begin{matrix}OAz_2O\\OH\end{matrix}\right.\right)$.
25. —
26. Basic nitrate.
27. Plumbic hydronitrate ($PbNO_3HO$).
28. Azotate diplombique $(AzO_3)_2Pb,PbO$ or parazotate, $(Az_2O_7)Pb_2$, or orthoazotate $(AzO_4)'''\dot{P}b''H$.
29. —
30. Halbgesättigt hydratisch basisch Salpetersauresblei.
31. Basisches Salz $\left(\begin{matrix}NO_2\\H\end{matrix}\right\}O_2Pb\right)$.

* Consisting of Professors Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary), and V. H. Veley.

† Read at the British Association, Aberdeen Meeting, Section D.

32. Basic nitrate.
33. Dibasic plumbic nitrate (Pb_2NO_3,PbH_2O_2).
34. Basic nitrate, $Pb(NO_3)OH$.
35. Plumbic nitrate hydrate, $NO_2(OPb''Ho)$.
36. Basic salt.

IX.

1. Submuriat of lead.
2. Submuriate of lead.
3. Submuriate of lead.
4. —
5. —
6. —
7. —
8. Oxychloride of lead.
9. Bibasic chloride of lead ($PbCl+2PbO$), Tribasic ($PbCl+3PbO$).
10. —
11. —
12. —
13. Einfach-, zweifach-, &c. basisches Chlorblei ($PbCl+PbO$), &c.
14. —
15. —
16. Oxychloride of lead.
17. Oxychlorure.
18. —
19. Basische Bleichloride, Oxychlorid, Bisoxychlorid, &c. ($PbO,PbCl,2PbO,PbCl$, &c.)
20. Oxychlorides of lead ($PbO,PbCl$, &c.).
21. Oxychlorure.
22. —
23. Oxychlorides (Pb_2Cl_2O or $PbCl_2PbO$, &c.), 1881, III. Supp.
24. Oxychlorures de plomb.
25. —
26. Oxychlorides ($PbCl_2,PbO$, &c.).
27. Basic plumbic chlorides ($Pb_2OCl_2,Pb_3O_2Cl_2$, &c.).
28. —
29. Oxychlorides of lead ($PbCl_2,PbO$, &c.).
30. Diplumboxydchlorür; Triplumbdioxydchlorür, &c.
31. Basische Salze.
32. Oxychlorides ($PbCl_2$, PbO, &c.).
33. Oxychlorides of lead ($PbO,PbCl_2$, &c.).
34. Basic chlorides ($PbCl_2+PbO$, &c.).
35. Oxychlorides.
36. Oxy- or basic chloride.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 4th, 1886.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Carl Bennert, Ph.D., Blaydon, near Newcastle; Edwin Ebenezer Burnett, 118, Huddleston Road; Arthur Robert Ling, 14, Woburn Place, Russell Square, W.C.; Frank Morel, Aldergate Chemical Works, Southall; Dr. Robson Roose, 45, Hill Street, Berkeley Square, W.

The following were elected Fellows of the Society:—Messrs. James Henry Allan, Henry K. G. Bamber, Leopold Mandeville Deane, Preo Loll Dey, Adolph Dresel, Herbert Samuel Elworthy, John William Ellis, Caleb Ferrey, M.B., B.Sc., James Arthur Formoy, Francis W. L. Glenfield, Bertram Harvey Hart, Andrew Henderson, George Thomas Holloway, Arthur Percy Hoskins, William Lang, jun., Arthur Pillans Laurie, Peter MacEwan, Walter Newton, Eugene Obach, Oliver Quibell, James Galbraith Ross, Richard Spencer, Arthur John Starey, Francis Napier Sutton, Charles Metford Thompson, Julius Wertheimer, Sidney Williamson, Edward Willmore, William T. Wright, and Brougham Young.

19. "*A New Element: Germanium.*" By CLEMENS WINKLER.

The author, in a letter addressed to the Society, dated Freiburg, Saxony, February 21st, 1886, states that he has discovered in the mineral *Argyrodite* a new non-metallic element, closely related to arsenic and antimony, and that he has named it *Germanium*.

Argyrodite is a new mineral discovered at Freiburg by by A. Weisbach, consisting of silver, sulphur, and germanium.

20. "*The Influence of Temperature on the Heat of Chemical Combination.*" By S. U. PICKERING.

A large number of experiments have been made by the author, with the view of ascertaining whether the heat of combination is independent of temperature, or whether, if not, the variations are of a regular nature. According to Kopp's determinations of specific heats, the heat of combination of solids should be uninfluenced by temperature, but the methods available for ascertaining specific heats would be too imperfect to show any alterations in the heat of combination unless these were very great. The particular cases selected were the heat of hydration of a salt and the heat of formation of double salts. The sulphates were the salts chosen.

Every means was adopted for rendering the experiments as precise as possible; the temperatures employed were confined within the ordinary range of atmospheric temperatures; as many as seven different thermometers were used, the more delicate of which read to less than 1/3000° C., and a method was devised whereby the same portion of any instrument was used for every experiment with any particular substance, whatever the temperature might be. The proportion of salt to water taken was 1:400 formula weights with the single sulphates, and 1:800 with the double sulphates.

Hydrates in Solution.—The results when plotted as curves exhibit very remarkable features. In no case is the heat of dissolution of any of the salts represented by a straight line, nor even by a single curve, but consists of a series of curves more or less regular in their nature.

Hydrated potassium magnesium sulphate exhibits the greatest number of such changes; a straight line may be drawn so as to touch, or nearly touch, the portions of the curves at 2·5°, 7·5°, 15°, and 22·5° C., the portions intermediate between these points corresponding about 100 calories above this straight line. Hydrated magnesium sulphate exhibits similar peculiarities, but fewer in number, the points of minimum heat evolution being about 3°, 14°, and 22° C. With hydrated copper sulphate the heat of dissolution appears to be represented by a series of straight lines rather than curves. Hydrated potassium copper sulphate presents the appearance of one curve, broken only by a deep indentation extending from 12·5° to 15°. With hydrated sodium sulphate there is a depression between 5·5° and 10·5°, the heat of dissolution above this point being probably represented by a straight or nearly straight line.

The curves of the anhydrous salts generally exhibit peculiarities resembling those of the corresponding hydrated salts, but not always. With potassium sulphate there is a break at 14°; a similar one occurs with lithium sulphate, but in the case of sodium sulphate such a break is absent. The curves of these three salts do not show any marked resemblance.

The increase in the heat of dissolution of a salt which thus takes place at certain temperatures can only be attributed, in the author's opinion, to the formation of some new and higher hydrate. That an increase of temperature should favour the formation of such is not considered extraordinary, when it is remembered that the temperatures at which the observations were made are comparatively low, and that with sodium sulphate, where we have other reasons for considering a high temperature would

favour the dissociation of the salt from its water, no such increase takes place after 10·5°, a much lower temperature than in any other case. No special changes were noticed at 4° C., the temperature of the maximum density of water. The author considers that the heat of formation of these higher hydrates is probably not an inconsiderable quantity in comparison to that of the known hydrates of the salt, but it is impossible to determine its exact value in any special case.

The occurrence of these successive changes in the constitution of a salt in solution will involve successive variations in the specific heat of their solution; the temperature of the latter, therefore, will rise under the influence of a constant source of heat, not in a regular but in an undulatory manner.

Water of Crystallisation.—A comparison of the heat of dissolution of the same salt in the hydrated and anhydrous condition gives the heat of formation of the solid hydrated salt. When the various values obtained for this at different temperatures are represented diagrammatically they form a series of curves showing that the heat of this combination is not a constant quantity. With magnesium sulphate the heat of hydration increases from 13,100 cals. at 3° to 13,300 cals. at 23°, there being a small but questionable break at 14° C. With copper sulphate the variation is much more marked; the line forms one curve from 2° to 9°, another from 9° to 17°, after which it again rises, attaining the value of 11,320 cals. at 23°, whereas at 2° it was only 10,780 cals. The heat of hydration of the double salts shows similar irregularities, as well as a similar tendency to increase with the temperature. With sodium sulphate only is a decrease in value observed as the temperature rises, this decrease beginning at about 15°, after experiencing some remarkable fluctuations at lower temperatures.

These fluctuations in the heat of hydration of a salt the author attributes to intramolecular re-arrangements; changes of a nature similar to those which cause the same substance, sometimes even when an element, to exhibit different physical and chemical properties. The general tendency towards an increase in the heat of combination as the temperature rises is in accordance with what has already been observed in other cases.

From these variations in the heat of hydration it follows that the specific heat of a solid hydrated salt will be subject to small variations, as in the case of its solution, and also that it will not be exactly equal to the sum of the specific heats of the anhydrous salt and water, but generally slightly less.

It is observed that the temperature at which the heat of hydration of a solid salt is a minimum corresponds to an increased heat in the dissolution of the hydrated salt, as if the possibility of a higher hydrate being formed were due to there being less energy expended in retaining the water already combined.

Double Salts.—The heat of formation of the double salts, $MgSO_4,K_2SO_4$ and $CuSO_4,K_2SO_4$, in the solid and anhydrous condition, was calculated from the data already alluded to. This quantity appears to vary also with the temperature; with both salts it attains a minimum at about 14°, the extreme variation with the copper compound being as much as 640 cals., from −240 cals. to +400 cals. One of the most remarkable features in the variation of this quantity is that an increase in it occurs at those temperatures which are marked by a *decrease* in the heat of combination of the same double salt with its water of crystallisation, thus bearing out the conclusions previously drawn from a comparison of this latter quantity with the heat of dissolution, as to there being some principle of intramolecular compensation, whereby an increase in the energy of combination between any two portions of a molecule can take place only at the expense of the energy between these and the other portions.

21. "*The Salts of Tetrethylphosphonium and their Decomposition by Heat.*" By Professor E. A. Letts and Norman Collie, Ph.D.

The authors confirm Hofmann's statement that *tetrethylphosphonium hydroxide* is resolved on heating into ethane and triethylphosphine oxide; the change occurs quantitatively. The *chloride*, PEt_4Cl, is resolved quantitatively into triethylphosphine hydrochloride and ethylene. On heating the *carbonate* they obtained triethylphosphine together with its oxide, and diethylketone, carbon dioxide, and tetrane, whereas Hofmann and Cahours state that it yields triethylphosphine and ethyl carbonate. The *acid carbonate* behaves similarly. The *acetate* appears to undergo two distinct changes, and to be resolved partly into triethylphosphine oxide and methylethylketone, and partly into triethylphosphine, carbon dioxide, ethylene, and methane. The *benzoate* is decomposed in a similar manner, ethylphenylketone and benzene taking the place of ethylmethylketone and methane. The products of decomposition of the *oxalate* at 200° to 300° are triethylphosphine and its oxide, ethylene, carbon monoxide and dioxide, and perhaps diethylketone. If the oxalate be heated to 160° with the minutest trace of sulphur, a deep indigo-blue colour becoming green and finally yellow is produced: this reaction furnishes an excellent test for sulphur. The *sulphate* yields almost quantitative amounts of triethylphosphine sulphide and oxide, together with charred products. A concentrated solution of the *cyanide* decomposes when heated, and yields triethylphosphine oxide, ethane, and hydrogen cyanide; a small quantity of what appears to have been propionitrile was also obtained. The *iodide* decomposes in a complex manner, and yields charred products.

22. "*The Formation of Acids from Aldehydes by the Action of Anhydrides and Salts, and the Formation of Ketones from the Compounds resulting from the union of Anhydrides and Salts.*" By W. H. Perkin, Ph.D., F.R.S.

The method of preparing unsaturated acids from aldehydes discovered by the author has of late been the subject of much discussion, Fittig especially contending that condensation takes place between the aldehyde and the *salt*, and not, as the author supposes, between the aldehyde and the *anhydride*. Believing the arguments put forward by those who oppose this latter interpretation to be inconclusive, he has resumed the study of the subject; the experiments are as yet incomplete, however, and only one observation bearing on the question is fully discussed in the paper. The author has previously shown that when a mixture of isobutyric anhydride, sodium isobutyrate, and benzaldehyde is heated, carbon dioxide and butenylbenzene are produced; these result from the decomposition of phenylhydroxyisobutyric acid, which Fittig has proved to be the first product of the reaction. He now finds that on heating a mixture of benzaldehyde, isobutyric anhydride, and an acetate, about 60 per cent of the theoretical amounts of butenylbenzene and carbon dioxide are obtained; whereas, on employing acetic anhydride and sodium isobutyrate cinnamic acid was obtained in considerable quantity, and less than half as much carbon dioxide and butenylbenzene as in the previous experiments. These results afford strong evidence that condensation takes place between the aldehyde and the anhydride, and not between the aldehyde and the salt.

The paper mainly consists of an account of the results obtained on heating anhydrides with their salts. On boiling a mixture of butyric anhydride and sodium butyrate, carbon dioxide is gradually evolved and dipropylketone is formed. Isobutyric anhydride and sodium isobutyrate react in a similar manner. A mixture of sodium propionate with excess of propionic anhydride, heated in sealed tubes at 180—190°, yields carbon dioxide and diethylketone; and acetone is obtained in like manner from acetic anhydride and an acetate. The author believes that the formation of the ketone depends on the interaction of the salt and the anhydride, and that this is the case appears to be proved by the observation that methylpropylketone is obtained if a mixture of sodium acetate and butyric anhydride be heated.

23. "*A New Method of Preparing Tin Tetrethide.*" By Professor E. A. Letts and Norman Collie, Ph.D.

In preparing zinc ethide by Gladstone and Tribe's method, the authors obtained a liquid by-product which they ultimately ascertained was tin tetrethide. Experiments were therefore made with zinc-tin alloys containing from 1 to 50 per cent of tin; the yield of tin tetrethide, calculated as percentage of tin converted, varied from 27–56 per cent, but in most of the experiments about 50 per cent of the tin present was converted, whatever the composition of the alloy. The yield of tetrethide was almost proportional to the mass of tin in the alloy until it contained one-third tin; it then became almost inactive, and the time necessary to complete the reaction increased enormously. On adding powdered tin to the zinc-copper couple together with ethyl iodide, tin tetrethide was produced on heating; and a similar result was obtained when zinc ethiodide was heated with powdered tin, but it was necessary to raise the temperature to 160°. Alloys of zinc with 20 per cent antimony, aluminium, bismuth, and lead, when heated with ethyl iodide, gave only zinc ethide.

24. "*Contributions to the History of Cyanuric Chloride.*" By Alfred Senier, M.D.

On heating together cyanuric chloride, $C_3N_3Cl_3$, and sodium acetate in closed tubes at 100°, sodium cyanurate, $C_3N_3O_3Na_3$, and acetyl chloride are produced, but interaction takes place only partially. Silver acetate is not attacked by the chloride; and cyanuric acid and acetic anhydride do not act on each other. On heating sodium formate with cyanuric chloride, sodium cyanurate, carbonic oxide, and hydrogen chloride are formed. Sodium benzoate and cyanuric chloride give benzoyl chloride and sodium cyanurate, 88 per cent of the theoretical yield of the former being obtained. The action of cyanuric chloride on benzamide is similar to that of phosphorus pentachloride, and results in the formation of cyanuric acid, benzonitrile, and hydrogen chloride. *Benzoyl cyanurate*, $C_3N_3(C_7H_6O_2)_3$, is readily obtained on heating a mixture of benzoyl chloride and silver cyanurate at 100°; it is readily hydrolysed, if heated for a short time with water at 100°, into benzoic and cyanuric acids.

25. "*The Action of Naphthylamine on Cyanuric Chloride.*" By Harold H. Fries.

The author has succeeded in displacing the three chlorine-atoms in cyanuric chloride one by one by the group $NH{\cdot}C_{10}H_7$. The dichloride, $C_3N_3Cl_2(NH{\cdot}C_{10}H_7)$, and the monochloride, $C_3N_3Cl(NH{\cdot}C_{10}H_7)_2$, are obtained on mixing the proper quantities of cyanuric chloride and naphthylamine, both dissolved in ether; they crystallise from hot alcohol in needles, the former melting at 149°, the latter at 215°. When either of these bodies is heated with the proper quantity of amine at 100°, *naphthylmelamine*, $C_3N_3(NH{\cdot}C_{10}H_7)_3$, is formed; it melts at 223°.

26. "*Sulphine Salts containing the Ethylene Radical.*" Part I. *Diethylene-sulphide-methyl-sulphine Salts.*" By Orme Masson, M.A., D.Sc.

Two substances of the empiric formula C_2H_4S have been described, one being an amorphous insoluble non-volatile compound, concerning whose constitution nothing is known; the other is crystalline, dissolves in alcohol, ether, and carbon disulphide, boils at 200°, and, as Husemann has shown, has a vapour-density corresponding to the formula $(C_2H_4)_2S_2$. The author describes the preparation of this latter; he then discusses its constitution, showing that it is adequately represented by the formula $S\begin{Bmatrix}C_2H_4\\C_2H_4\end{Bmatrix}S$.

This sulphide unites directly with methyl iodide to form *diethylene-sulphide-methyl-sulphine iodide*—

$$S\begin{Bmatrix}C_2H_4\\C_2H_4\end{Bmatrix}S\begin{Bmatrix}CH_3\\I\end{Bmatrix}$$

A series of derivatives prepared from this iodide are described, viz.:—The iodide, $C_5H_{11}S_2I$; the tri-iodide, $C_5H_{11}S_2I_3$; the nitrate, $C_5H_{11}S_2NO_3$; the silver salt, $C_5H_{11}S_2NO_3{\cdot}AgNO_3$; the sulphate, $2(C_5H_{11}S_2)_2SO_4{\cdot}7H_2O$; the chloride, $C_5H_{11}S_2Cl$; the chloroplatinates—

$$(C_5H_{11}S_2Cl)_2PtCl_4, (C_5H_{11}S_2Cl)_4{}_3PtCl_4, (C_5H_{11}S_2Cl)PtCl_4, C_{10}H_{21}S_4Pt_2Cl_9);$$

the gold salt, $C_5H_{11}S_2Cl{\cdot}AuCl_3$; the mercury salt—

$$C_5H_{11}S_2Cl{\cdot}HgCl_2;$$

the hydroxide, $C_5H_{11}S_2OH$; a volatile oil, $C_{12}H_{24}S_5$.

In their general characters the salts of the base resemble those of trimethyl-sulphine, but they differ in some important particulars, of which the following are the most striking:—

1. There is much less tendency to form addition products with the halogens.
2. The salts are decomposed by potash.
3. The hydroxide undergoes a peculiar decomposition, slowly when cold, rapidly on heating; the chief product of which is the oil $C_{12}H_{24}S_5$.
4. The compounds formed by the chloride with platinic chloride are peculiarly various, and are possessed of characteristic properties.
5. None of the salts examined, with the exception of the sulphate, is at all deliquescent.

The constitution proposed by the author for this sulphine base represents it as trimethyl-sulphine in which two methyl-groups are displaced by the dyad (comparatively negative) group $S(C_2H_4)_2$. This view of their constitution affords an explanation of the first two of the above-mentioned characteristics of the base.

27. "*Sulphine Salts containing the Ethylene Radical.* Part II. *On Dehn's Reaction between Ethylene Bromide and Alkyl Sulphide.*" By Orme Masson, M.A., D.Sc.

In 1865 Dehn published an account of the action of ethylene bromide on ethyl sulphide (*Annalen*, Suppl. IV., 83), which he summed up in the following scheme:—

(1.) $2C_2H_4Br_2 + 2(C_2H_5)_2S = (C_2H_4)_2S_2 + 4C_2H_5Br.$
(2.) $C_2H_5Br + (C_2H_5)_2S = (C_2H_5)_3S.$
(3.) $C_2H_4Br_2 + (C_2H_5)_2S = (C_2H_5)_2(C_2H_4)S^{VI}Br_2.$
(4.) $C_2H_4Br_2 + C_2H_4S = (C_2H_4)_2S_2{}^{VI}Br_2.$

The truth of equations (1) and (2) was well proved; that of (3) and (4) rested on rather doubtful evidence.

If the compounds $(C_2H_5)_2(C_2H_4)S^{VI}Br_2$ and—

$$(C_2H_4)_2S^{VI}Br_2$$

really exist, they are unique specimens of a class of sulphinic salts, and are of considerable theoretic interest. An investigation, however, of the circumstances attending the formation of the salts to which Dehn attributed these formulæ, of the properties of their platinum salts (as described by Dehn), and of the analyses on which this theory was based, conclusively shows that Dehn was really dealing with salts analogous to those described by the author in Part I. of this communication. The author supports this conclusion by proving that sulphine salts possessed of the required properties are actually formed when diethylene disulphide is heated with ethyl bromide and with ethylene bromide. He therefore substitutes the following equations for Dehn's third and fourth:—

(3.) $C_2H_5Br + (C_2H_4)_2S_2 = (C_2H_4)_2S_2(C_2H_5)Br.$
(4.) $C_2H_4Br_2 + (C_2H_4)_2S_2 = \{(C_2H_4)_2S_2\}_2(C_2H_4)Br_2.$

28. "*The Identity of Certain Mixed Ethereal Oxalates.*" By L. Gordon Paul.

The author has compared the methylic ethylic oxide obtained, 1, by adding the theoretical amount of $CH_3{\cdot}OH$ to the chloride $COCl{\cdot}COOEt$, and 2, by adding the theoretical amount of $C_2H_5{\cdot}OH$ to the chloride $COCl{\cdot}COOMe$, and concludes that the two reactions furnish the same product. If an excess of alcohol be used, methylic oxalate in the one case, and ethylic oxalate in the other, is obtained in place of the mixed salt; but whereas the displacement of ethyl by methyl takes place at once and is very complete, that of ethyl by methyl is much more gradual and less complete. Methylic oxalate may be converted into ethylic oxalate by heating it with methylic

alcohol, and *vice versâ*. Methylic ethylic oxalate is converted by repeated distillation into a mixture of methylic and ethylic oxalates.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, March 1, 1886.

WARREN DE LA RUE, M.A., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

THE following were elected Members of the Royal Institution:—

John Abercrombie, Sen., M.D., F.R.C.P., William Henry Barlow, Esq., F.R.S., M. Inst. C.E., Alfred Carpmael, Esq., Henry Doetsch, Esq., John Piggin Fearfield, Esq., R. Gent-Davis, Esq., M.P., John Hopkinson, Esq., M.A., F.R.S., John Inglis, Esq., Major E. Cecil Johnson, Mrs. T. C. Leitch, Mrs. S. Joshua, George Palmer, Esq., Sir Ughtred Kay-Shuttleworth, Bart, M.P., Silvanus P. Thompson, Esq., Sir William Thompson, D.C.L., LL.D., F.R.S., Walter Tomlinson, Esq., M.A.

Seven Candidates for Membership were proposed for election.

The Presents received since the last Meeting were laid on the table and the thanks of the Members returned for the same.

UNIVERSITY COLLEGE, LONDON.

CHEMICAL AND PHYSICAL SOCIETY.

Thursday, March 4th, 1885.

C. E. CASSAL, F.I.C., F.C.S., President, in the Chair.

"*On some Antiseptics for Food Preservation.*" By H. L. SULMAN and E. E. BERRY, F.C.S.

The authors described their experiments on the antiseptic properties of the various borates, salicylates, and benzoates; especially with regard to the preservation of milk, for which purpose the two former classes have been extensively recommended and used.

Of the borates the free acid itself possesses the greatest efficiency; and several of the widely-advertised antiseptic compounds—such as "*aseptin*," "*glacialine*," and "*boroglyceride*," which contain boracic acid in admixture with borax, alum, glycerin, &c.—were found to owe their power almost entirely to their ratio of contained free H_3BO_3.

A sample of the last-named compound, "*Barff's boroglyceride*," purporting to be the boracic ether of glycerin, $C_3H_5BO_3$, was analysed, and found to consist of about 25 per cent of the true ether, with 75 per cent of free boracic acid and glycerin in equivalent proportions. In experimenting with the true compound (the ice-like solid) the authors obtained results slightly differing from the published descriptions, inasmuch as the addition of water in *any* proportion was found to immediately resolve the glyceric borate into the free acid and glycerin. This decomposition therefore occurs on adding the compound to any aqueous liquid, or when it is brought into contact with any animal tissue; and, in view of the necessarily somewhat restricted quantity of antiseptic capable of being used, the liberated glycerin has practically no antiseptic action. Hence it follows that the value of "boroglyceride" is entirely dependent upon the 45 to 50 per cent of free H_3BO_3, which it liberates on use. And its advertised beneficial effects in antiseptic surgery and in food preservation will be equally well obtained by employing half the quantity of the far cheaper boracic acid.

In reviewing the available evidence with regard to the physiological effects produced by the constant administration of small doses of boracic acid and the borates in food, the authors decide strongly against their employment as agents for food preservation, especially when applied to milk, on account of the greater risk to children and infants.

The still more serious objections which can be urged on these grounds against the use of salicylic acid and the salicylates (which for food preserving have been penalised in France upon the advice of a late French Commission) are rendered unnecessary in the case of milk, by the fact that this generally potent class of antiseptics is utterly useless for the purpose.

Benzoic acid is useless, owing to its tendency to precipitate the casein; but the best results were obtained by the use of sodic benzoate, which is quite tasteless, is one-third more powerful than boracic acid, and is entirely unattended by any evil physiological effects when taken in small quantities for prolonged periods.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 8, February 22, 1886.

On the Equivalent of the Terbias.—Lecoq de Boisbaudran.—Inserted in full.

Use of Potassium Sulphate in the Fractionations of the Rare Earths.—Lecoq de Boisbaudran.

Analysis of Air collected at Cape Horn.—A. Müntz and E. Aubin.—The mean percentage of oxygen found was 20·864.

Action of Gaseous Hydrochloric Acid upon Iron.—F. Isambert.—The proportion of hydrogen set free in the gaseous mixture is so much the smaller as the temperature is higher. Thus a gas which no longer acts upon iron at the temperature of dull redness contains from 89 to 91 per cent of hydrogen, at bright redness from 67 to 69, and at a still higher temperature only 55 per cent. The action of hydrochloric acid, therefore, follows the same course as that of watery vapour upon iron in the experiments of H. Deville. The pressure of the gaseous mixture does not seem to exert any influence.

New Researches on the Alkaline Earthy Manganites.—G. Rousseau.—As the temperature falls the manganous acid combined with lime tends to become polymerised.

Observations relative to M. Joly's Note on the Titration of Phosphoric Acids by means of various Indicators.—R. Engel.—M. Joly in his investigation on the titration of phosphoric acid with various indicators concludes that the blue C4B, the reactions of which the author has studied, does not admit of "precise application." If this *savant* has in view merely the determination of phosphoric acid he combats an opinion which M. Engel has never advanced. The latter has, in fact, pointed out that on titrating disodic phosphate with normal potassa the change of colour begins at the 50th degree, whilst 59 degrees are theoretically necessary. Under the most favourable circumstances there would be therefore an error of about 16 per cent. The figures which M. Joly finds show that disodic phosphate, alkaline to litmus, is acid to the soluble blue, but the number of c.c. of normal potassa necessary to arrive at the point where the change of colour begins is smaller in M. Joly's experiments than in those of M. Engel. The latter used a concentrated solution, whilst M. Joly diluted 1 eq. of phosphoric acid with 6 litres of water. But it is well known that the trisodium and tripotassium phosphates are readily decomposed by water. The author considers that we may safely doubt the existence of a reagent, which in all grades of dilution will indicate the neutralisation of feeble acids,

or that of bodies having similar chemical functions. Thus the blue C_4B, which permits of the determination of prussic acid in a 25 per cent solution, is quite unfit for the determination of the same acid in laurel water. The law of definite proportions and that of multiple proportions do not hold good in all cases when the question is the neutralisation of dissolved acids by bases. The author has recently shown that on adding to a mol. of oxalic acid a mol. of ammonia or potassa the solution obtained does not contain respectively the acid oxalate of these bases, but a mixture of the neutral and the acid oxalate and the quadroxalate. If a little more or a little less of these acids is added the three salts still exist.

The Formation of Monatomic Alcohols derived from the Oil of Turpentine.—MM. Bouchardat and Lafont.—The authors have already shown that setting out from French oil of turpentine several acetates may be obtained of the same formula, but of very different properties. From these acetates the authors have since obtained the corresponding monatomic alcohols.

The Action, in the Cold, of Alcoholic Chlorides upon Ammonia and upon the Methylic Amines.—MM. Vincent and Chappuis.—This paper does not admit of useful abstraction.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Part 1 and 2.

A New Process of Ascertaining the Vapour-Density of Volatile Bodies Combined with an exact Determination of the Temperature.—L. F. Nilson and Otto Petterson.—This memoir requires the two accompanying plates.

On Polymeric Trichlor-acetonitril.—A. Weddige.—An inquiry into the molecular magnitude and the constitution of para-cyan-carbonic-ethyl-ether.

Behaviour of Alkaline Hydrosulphides with Compound Ethers.—Christian Göttig.—It appears that acetic ether, and probably other ethers of its class, are not directly decomposed by the alkaline hydrosulphides, but only after the decomposition of these sulpho-bases.

Reply to H. E. Beyer on the "Action of Acetone upon Aniline."—C. Engler and P. Riehm.

Remarks on the above Reply.—C. Beyer.—A discussion on the right of Engler and Riehm to publish researches on a subject the continuation of which C. Beyer had reserved for himself in an earlier publication.

Action of Phenylhydrazin upon the Organic Anhydrides.—B. Hotte.—On heating equal mols. phthalic anhydride and phenylhydrazin to 150°, water is split off, and the resinous dark-red product yields phthalyl-phenyl hydrazin.

Chinolin Derivatives from Isatic Acid.—W. Pfitzinger.—Acetone in alkaline solution is condensed with isatic acid (two mols. of water being eliminated) to an acid of the composition of a methyl-chinolin- carbonic acid.

MISCELLANEOUS.

Petroleum.—At the Society of Arts on Monday, March 8th, Mr. Boverton Redwood, F.I.C., F.C.S., delivered the first of a Course of four Cantor lectures on "Petroleum and its Products." The lecturer commenced by giving a historical account of petroleum, pointing out that the valuable properties of this substance were undoubtedly well known to Herodotus and other historians who wrote during the five centuries preceding the Christian era, and that the inflammable nature of petroleum-gas was probably turned to account by the Persian Fire Worshippers as much as 2500 years ago. Having traced the progress of the petroleum and shale oil industries from their commencement to the present time, the lecturer proceeded to deal with the geographical and geological distribution of petroleum, and showed that there was hardly a country in which it had not been found, though not always in the same geological formation. The lecturer then referred to a representative series of specimens of petroleum from various parts of the world, in illustration of his statements as to the very variable physical characters of the material, and concluded by explaining the chemical composition of petroleum, showing that the Russian oil differs in this respect from the American, though carbon and hydrogen are the principal constituents of both.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sawdust.—Can any of your readers inform me by what process I can get a hard substance, such as can be moulded, from sawdust? I believe this is done by chemically reducing the sawdust to a pulp and submitting it to pressure.—J. N. Palmer.

MEETINGS FOR THE WEEK.

Monday, 15th.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Petroleum and its Products," by Boverton Redwood, F.C.S.
—— Society of Chemical Industry, 8. "Ice Making and Cooling Machinery," by T. B. Lightfoot, M.I.M.E.
Tuesday, 16th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
Wednesday, 17th.—Society of Arts, 8. "Eastern Carpets," by Vincent Robinson.
—— Meteorological, 7.
Thursday, 18th.—Royal, 4.30.
—— Philosophical Club, 6.30.
—— Chemical, 8.
—— Royal Institution, 3. "The Ancient Geography of Britain," by Prof. W. Boyd Dawkins, F.R.S.
Friday, 19th.—Royal Institution, 9. "Universal Time," by W. H. M. Christie, F.R.S., Astronomer Royal.
—— Society of Arts, 8. "Experiences on the Afghan Frontier," by William Simpson, F.R.G.S.
—— Geologists' Association, 8.
Saturday, 13th.—Royal Institution, 3. "The Nature and Protective Use of Colour in Caterpillars," by Edward B. Poulton, M.A.

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The Company has been formed for the purpose of purchasing and taking over as a going concern as from the 1st January, 1886, the well-known business of Messrs. BROOKE, SIMPSON, and SPILLER (whose term of partnership expires this year), Patentees and Manufacturers of Aniline Dyes. Merchants, and Dry-salters, carrying on business at the Atlas Works, Hackney Wick, E.; Metropolitan Chambers, 10, New Broad Street, E.C.; 106, Portland Street, Manchester; 47, Peel Place, Bradford; and 30, Market Street, Huddersfield.

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The Buildings, which are in excellent condition, and specially erected and adapted for the business, costing £37,103, have been taken at the figures shown in the last Balance-sheet, viz., £29,060, that is to say, less a depreciation of £8,043.

The Plant, Machinery, Engines, Boilers, Vats, Extractors, Condensers, &c., &c., the actual cost of which was £42,219, have been taken at the figures appearing in the last Balance-sheet, viz. £19,195, that is to say, less a depreciation on the cost of £23,024.

The Stocks of all finished products manufactured by the Vendors have been taken (and will be paid for in cash) at the prices charged in the last Balance-sheet, which are considerably less than the actual cost, and other Stocks and Raw Materials at and below cost.

It will thus be seen that any over valuation in the Land, Buildings, Plant, Stock, &c., has been carefully guarded against.

The consideration money to be paid for the Land, Buildings, Plant, and Goodwill, is the sum of £80,000, of which £40,000 will be paid by allotment to the Vendors of 2,000 A and 6,000 B fully paid up shares, and the Balance in cash.

AUDITORS' CERTIFICATE.

"15, Spring Gardens, Manchester,
20th February, 1886.

"Having regularly, every half-year, audited the books of Messrs. Brooke, Simpson, and Spiller, in London and Manchester, from the time they commenced business in 1868 up to the present, we hereby certify that from 1868 to 1877 exceptionally large profits were realised, the colours Magenta, Blue, and Violet being protected by Patents, the last of which expired in 1877; and that from the last-mentioned date to the end of 1885, the profits made and drawn have been such as would pay a dividend of over £12 per cent per annum on the share capital now proposed to be allotted.

(Signed) JOHN LITCHFIELD AND SONS,
Public Accountants."

GENERAL.

The Company acquire the property of the Vendors and take the profits as from the 1st January, 1886.

THE CHEMICAL NEWS.

Vol. LIII. No. 1373.

ON RADIANT MATTER SPECTROSCOPY:

Note on the Earth Yα.*

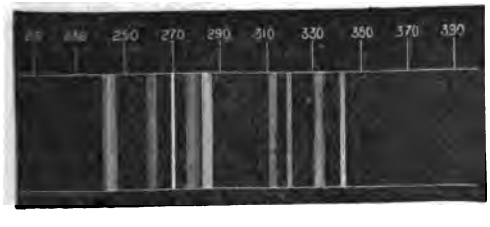
By WILLIAM CROOKES, F.R.S.

Among the samarskite earths which concentrate towards the middle of the fractionations there is one (or a group) which presents in the radiant matter tube a well marked phosphorescent spectrum differing from those I have already described.

The measurements of the bands and lines are given below:—

Scale of spectroscope.	λ.	$\frac{1}{\lambda^2}$.	Remarks.
10·325°	6446	2407	Approximate centre of a red band shaded off on the least refrangible side.
10·310°	6415	2430	Somewhat sharp edge of the red band.
10·185°	6189	2611	Approximate centre of a very faint orange band.
10·150°	6129	2662	Ditto Ditto.
10·130°	6094	2693	A sharp narrow orange-red line.
10·05°	5970	2806	Approximate centre of a narrow bright orange band. (Between this line and 2693 is a fainter semi-continuous orange band).
9·840°	5676	3104	Approximate centre of a narrow bright green band.
9·790°	5613	3174	Approximate centre of a narrow green band, not quite so bright as 3104.
9·690°	5495	3312	Approximate centre of a bright green band, wider than the other three green bands.
9·610°	5406	3422	Approximate centre of a narrow bright green band.

The accompanying figure gives the spectrum drawn to the $\frac{1}{\lambda^2}$ scale.



The earth giving the above spectrum, when sufficiently purified, presents all the characteristics of the earth discovered by Marignac, and provisionally called by him Yα.† Through the kindness of M. de Marignac I have been enabled to compare a specimen of Yα of his own preparation with the earth described above. The two earths agree in their chemical characteristics, and their phosphorescent spectra are practically identical.

No name has yet been given to this earth, as the discoverer appears to be in some doubt whether it is not identical with J. Lawrence Smith's earth mosandra.‡ A specimen of mosandra prepared by J. Lawrence Smith and sent me by M. de Marignac, gave a phosphorescent spectrum showing that it was compound, and that yttria was one of its constituents.

* A Paper read before the Royal Society, February 25, 1886.
† *Comptes Rendus*, xc., p. 899.
‡ *Comptes Rendus*, lxxxvii., p. 145; lxxxvii., p. 831; lxxxix., p. 480.

VALUATION OF COMMERCIAL PHOSPHATES.

An Agreement arrived at between the Chemists of the Experimental Stations and the Manure Manufacturers of South Germany, upon a New Basis for Establishing the Commercial Value of Superphosphate and Precipitated Phosphate.*

By Prof. PAUL WAGNER, Ph.D.

For the last twenty years the need has been felt for establishing a basis for determining the commercial value of phosphatic manures other than that dependent upon the amount of total and soluble phosphoric acid which they contain. Superphosphates made from such phosphates as Lahn phosphorite have, in consequence of their containing so-called "reverted" phosphate, a higher agricultural value than that indicated by the amount of phosphoric acid soluble in water which they contain; and since phosphatic manures consisting exclusively of precipitated phosphates insoluble in water have lately been brought in increasing quantities into the market, the need for some other basis for valuing manures has become more and more pressing.

R. Fresenius, in conjunction with Neubauer and Luck, found, as is well known, in neutral ammonium citrate, a salt which in solution of a suitable strength, and at a given temperature and time for extraction, proved serviceable enough for separating the precipitated phosphates from that portion of phosphorite superphosphate insoluble in water. This method, however, did not satisfy the requirements of the manure trade, inasmuch as the manurial value of this (reverted) phosphoric acid compared to that of phosphoric acid soluble in water was unknown. In order to solve this question Petermann and Grandeau carried out some experiments, from the results of which they concluded that phosphoric acid soluble in citrate was of the same value as phosphoric acid soluble in water. This, however, was disputed in Germany, and the joint meeting of agriculturists and chemists held at Karlsruhe, in the year 1879, passed the following Resolution:—

"This meeting recognises the value of reverted phosphate for certain kinds of soil, and is in no way opposed to its determination, if required by the agriculturist or manufacturer, but considers that the experiments hitherto made do not furnish evidence sufficient to establish a valuation of reverted and precipitated phosphates."

Field experiments were now carried out, whilst at the same time a method was sought for to effect the determination of phosphoric acid soluble in the soil. Of the field experiments on the value of reverted and precipitated phosphates one has gradually become tired; they led to no issue, and it was impossible that they could do so. They have again been abandoned. Attempts to find a means, by merely laboratory operations, of determining phosphoric acid "soluble in the soil" have also proved fruitless, and it was indeed scarcely possible that they could succeed, since the very expression "phosphoric acid soluble in the soil" conveys no precise meaning, and moreover the means employed for this end could not themselves be held free from objection.

Ammonium citrate, it has been urged, is an entirely unsuitable material for determining phosphoric acid "soluble in the soil," as it dissolves only insignificant quantities of phosphoric acid out of Peruvian guano, bone-meal, and other similar manures which experience,

* Translated and contributed by H. H. B. Shepherd. From *Chemiker Zeitung*, 1886, x., 1, 2, 3.

has shown contain much effective phosphoric acid. Free 1 per cent citric acid, on the other hand, has been recommended as being far better, since it not only dissolves precipitated phosphate quite as well as does ammonium citrate, but it also takes up some 70 or 80 per cent of the phosphoric acid contained in bone-meal and raw Peruvian guano, and shows besides that ground raw phosphorite contains about 4 per cent of phosphoric acid soluble in the soil, which at any rate is correct, "for no agricultural chemist doubts that ground raw phosphorite used in large quantities *does* produce a certain amount of effect."

My own experiments have shown, however, that the manurial value of phosphoric acid soluble in 1 per cent citric acid varies, according as it is presented to the plants in the form of precipitated phosphate of lime, washed-out high-class superphosphate, or finely ground phosphate. Supposing the manurial value of the phosphoric acid soluble in 1 per cent citric acid to be represented by 100 in the case of precipitated phosphate of lime, its value in the case of washed-out high-class superphosphate would be represented by 160, and in the case of finely-ground raw phosphorite by 2. Citric acid is therefore not a suitable means for dissolving out phosphoric acid from the different commercial phosphates in a manner that will compare with that effected by the soil and the roots of plants.

In addition, however, to ammonium citrate and free citric acid, potassium oxalate has been proposed as a menstruum, thus showing to what precision the whole question has shaped itself in the practice of the manure trade! Besides phosphoric acid soluble in water the agriculturist can purchase now-a-days reverted phosphoric acid, phosphoric acid soluble in the soil, soluble in citrate or in citric acid, root-soluble, half-soluble, and precipitated-assimilable phosphoric acid; and he can have his analyses made by the methods of either Fresenius, Petermann, Halle (18th December, 1881), Tollens-Stutzer, or Liebig, or by the Anglo-Continental method; and if the agriculturist enquires what value is to be attached to these many-styled forms of phosphoric acid, he is told that this is not yet accurately known.

For some years I have been endeavouring to establish the ground-work necessary to throw some light upon this confused state of matters, and I proceeded upon the following lines:—If the agriculturist be offered pure superphosphate of lime, it ought to be no difficult matter for him to obtain an opinion upon its value. If the manure merchant's price for phosphoric acid soluble in water averages about 58 pf. per kilo., the farmer knows that he he will be right in paying 11 marks 60 pf. per 100 kilos. for a superphosphate containing 20 per cent of phosphoric acid soluble in water. It is different, however, in the case of high-class and phosphorite superphosphates or precipitated phosphate. The buyer has then no idea in what relation the value of the precipitated phosphoric acid stands to soluble phosphoric acid of pure superphosphate of lime. If such manures are to be freely saleable, one should be able to inform the agriculturist positively what percentage of phosphoric acid equal in manurial value to phosphoric acid soluble in water is contained therein. If this could be done the buyer would be in a position to tell exactly how much he could afford to pay for the manure and how it should compare as regards cost with pure superphosphate of lime. For the requirements of the manure trade, therefore, an analytical method is wanted which will give the phosphoric acid of phosphorite superphosphate, of high-class superphosphate, and of precipitated phosphate, in their equivalents of phosphoric acid soluble in water, a method which will show how much per cent of phosphoric acid of the manurial value of phosphoric acid soluble in water is present, or, in other words, the manurial value of the material expressed in terms of phosphoric acid soluble in water. Or, if we call such phosphoric acid simply "soluble" phosphoric acid, and agree that by this term we are to understand phosphoric acid of the same manurial value as phosphoric acid soluble in water, then the question presents itself as follows:—

1. By means of manurial experiments to fix the relative manurial values of certain phosphatic manures expressed in terms of "soluble" phosphoric acid, *i.e.*, in terms of phosphoric acid of the same manurial value as phosphoric acid soluble in water.
2. To find an analytical method which shall furnish results agreeing exactly with the percentage of "soluble" phosphoric acid obtained by the manurial experiments.

This question has been my study during a long series of years. As regards the carrying out of my experiments, however, and the details which had to be taken into consideration, I must here confine myself to merely cursory references.

The manures which I used were the following:—

1. Pure superphosphate of lime.
2. A commercial precipitated phosphate of lime, prepared by precipitation in a strongly acid solution, and termed dicalcium phosphate.
3. A commercial precipitated phosphate of lime, precipitated with excess of lime, and termed tricalcium phosphate.
4. A washed-out high-class superphosphate.
5. A washed-out phosphorite superposphate.
6. Finely ground raw phosphorite.

I thought it unnecessary to include also the superphosphates 4 and 5 in the original unwashed-out condition, as, in the presence of so overwhelming an amount of phosphoric acid soluble in water, the effect of the precipitated phosphate contained in them would not have been sufficiently marked. The washing-out of the superphosphates was itself a matter for careful consideration, inasmuch as variations, both qualitative and quantitative, in the precipitated phosphoric acid, arise according as the wash-water at first poured upon the superphosphate is allowed to filter faster or slower through the mass. The quantity of the wash-water used and the length of time occupied by the washing have also their influence, and the variations thus caused would be sufficient to affect the results of the manurial experiments to such a degree as to render the carrying of them out in practical working inadmissible. In the examination of this question I now started with the following consideration:—It is necessary in superphosphates to distinguish between—

1. The phosphoric acid which goes into solution on treating 20 grms. of superphosphate with 1 litre of water for two hours, and—
2. The phosphoric acid which remains undissolved in the residue.

The manurial value of the phosphoric acid referred to under 2 must be obtained by means of manurial experiments, and a suitable material for such experiments can be prepared by digesting 20 grms. of superphosphate in 1 litre of water, or 200 grms. in 10 litres, for two hours, with frequent shaking, collecting the residue upon a filter, and, without further washing, allowing it to dry at the ordinary temperature of the air. In this way I produced the so-called washed-out superphosphates. I must further remark that I carried out the experiments in zinc vessels holding about 16 kilos. of earth, and that I experimented upon three kinds of soil, viz., sandy soil poor in lime, loamy soil containing lime, and Rhenish-Hessian soil rich in lime. The moisture in the soil was kept as constant as possible, and at about the medium percentage (10 to 15). The crops upon which I experimented were barley, oats, peas, and grass.

I have already frequently expressed myself concerning the peculiarities of the results obtained by my method, but I now briefly communicate the following:—

1. The phosphoric acid found in bicalcium phosphate by the Fresenius method proved equal in value to 100 per cent of phosphoric acid soluble in water.

2. The phosphoric acid found in the tricalcium phosphate by the Fresenius method proved equal in value to 75 per cent of phosphoric acid soluble in water.
3. The phosphoric acid found in the washed-out high-class superphosphate and phosphorite superphosphate by the Fresenius method proved, on the average, equal in value to 70 per cent of phosphoric acid soluble in water.

I must here remark that these data have reference to the action which the phosphates, applied in the spring at seed-time, exercised on the crops; the so-called "after-effects" of the phosphates are therefore left out of consideration. Arrangements for carrying out the experiments so as to show indubitably the after-effects of the manures have only been at my disposal since the beginning of the year 1885, and I have naturally not yet been able to bring the work in connection with them to a conclusion.

4. The results of the manurial experiments give the following percentages of "soluble" phosphoric acid,—*i. e.*. of phosphoric acid equal in value to phosphoric acid soluble in water, contained in the manures used:—

	"Soluble" phos. acid.
Bicalcium phosphate	30·6 per cent.
Tricalcium ,, ...	16·4 ,,
Washed-out high-class superphosphate	17·9 ,,
Washed-out phosphorite superphosphate	3·0 ,,
Finely-ground raw phosphorite ..	0·1 ,,

Having obtained these results the first part of my task was accomplished. In five different phosphatic manures the percentages of "soluble" phosphoric acid was obtained, and it still remained to find a menstruum which under the same circumstances would dissolve phosphoric acid out of each manure in the above proportions,—that is to say, 30·6 per cent out of bicalcium phosphate, 16·4 per cent out of tricalcium phosphate, and 17·9 per cent out of washed-out high-class superphosphate.

After many experiments with all possible organic acids I arrived at the same conclusion as Tollens and Stutzer, viz., that of all organic acids citric alone can be considered admissible; but even this acid, or at any rate the exclusive use of it, proved unsuitable, since its action upon phosphate of iron and alumina is too weak in comparison with its action upon phosphate of lime. I therefore made experiments with its ammonium salts, and came to the same opinion as Fresenius, viz., that of all salts of citric acid only the ammonium citrate can be considered available. It followed from this that in a suitable mixture of neutral ammonium citrate and free citric acid the properties of both would combine to form a solvent available for the various phosphates. A few preliminary experiments confirmed this supposition.

Now that the preliminaries of the required method had been decided upon, I determined to take into consideration the details of the process and all the practical requirements necessary for a method intended to further the object in view.

I essentially kept in mind the following considerations:—

1. The method must allow of superphosphate being treated directly, *i.e.*, without having first to remove the phosphoric acid soluble in water.
2. In order that there may be no difficulty in obtaining a representative sample, sufficient of the material under examination must be taken for extraction (at least 5 grms. per ½ litre).
3. The length of time to be decided upon for the extraction must be such that in the event of 30 or 40 superphosphates being in hand at once they can be dealt with without inconvenience. The longer the time agreed upon for extraction, the less likely can any deviations from such time affect the results, and provided it be observed within an hour one way or the other, I recommend as most convenient that the period for extraction be from one day to the next.
4. Also the prescribed degree of temperature must be such as to render its maintenance easily controlled, so that deviations may not lead to differences. The so-called temperature of the room, 13° to 18° C., is most to be recommended.
5. The method must admit of the substance being rubbed fine, for in no other way can uniformity in the results be obtained.
6. A sufficient quantity of the menstruum must be available for rubbing up the substance. 100 c.c. of citrate solution are not enough for conveniently dealing with 5 grms. of substance.
7. The determination of the phosphoric acid must be made in the extract and not indirectly in the residue, and the phosphoric acid must be precipitated by molybdenum, so that the results turn out exact and reliable.

Having regard to these seven essentials I arrived, after many experiments, at the following method:—5 grms. of superphosphate or precipitated phosphate are rubbed up with some dilute citrate solution, poured into a half-litre flask, made up to the mark with dilute citrate solution, allowed to stand about 18 hours at the temperature of the room (13° to 18° C.), with frequent shaking, and then filtered.

50 c.c. of the filtrate are then treated with molybdenum solution, so that 1 c.c. shall be present for every milligrm. of phosphoric acid, and to this mixture as much concentrated ammonium nitrate solution is added as would amount to a fourth of the mixture. After standing for about 20 minutes in the water-bath it is allowed to cool and is then filtered; the precipitate is washed on to the filter with a dilute solution of ammonium nitrate, a hole made in the filter, and the precipitate washed back into the beaker with dilute ammonia (2½ per cent); the filter is well washed, and to the ammoniacal solution 20 c.c. of magnesia mixture are added drop by drop with constant stirring. After standing for one hour the precipitate is filtered off, washed with dilute ammonia (2 per cent) dried, and ignited.

Preparation of the necessary Solutions.

1. Concentrated citrate solution. 150 grms. of citric acid are placed in a litre flask, dissolved in water, and neutralised with ammonia. To the neutralised solution 10 grms. of citric are added, and the solution made up to the mark with water.
2. Dilute citrate solution. 1 volume of concentrated citrate solution is mixed with 4 volumes of water.
3. Concentrated ammonium nitrate solution. 750 grms. of ammonium nitrate are dissolved in water and the solution diluted to a litre.
4. Dilute ammonium nitrate solution. 100 grms. of ammonium nitrate are dissolved in water and the solution diluted to a litre.
5. Molybdenum solution. 150 grms. of ammonium molybdate are dissolved in water, the solution diluted to a litre, and mixed with a litre of nitric acid of sp. gr. 1·2.
6. Magnesia mixture. 110 grms. of pure crystallised magnesium chloride and 140 grms. of ammonium chloride are dissolved in 1300 c.c. of water and 700 c.c. of ammonia (8%).

I now give the results I obtained by this method in comparison with those calculated from the mean results of the manurial experiments.

These results agree satisfactorily, and it may be reasonably accepted that my method gives figures which show sufficiently near the truth the agricultural value of phosphorite superphosphate, high-class superphosphate, and

"Soluble" Phosphoric Acid.

	Calculated from the results of the manurial experiments.	Obtained by analysis.
	Per cent.	Per cent.
Bicalcium phosphate	30·6	29·3
Tricalcium ,, ...	18·0	19·1
Washed-out high-class superphosphate	17·9	16·9
,, phosphorite ,,	3·0	3·3
Finely ground phosphorite	0·1	0·6

precipitated phosphate in terms of phosphoric acid soluble in water.

It is now self-evident that the method could be further devoloped, and had not external pressure been brought to bear upon me I would have hesitated before proposing to introduce it at once into the practice of the manure trade. Requests to make determinations of phosphoric acid soluble in citrate in the above-named manure materials have, however, been so frequent of late at the experimental stations at Bonn, Darmstadt, Speier, and Wiesbaden that the immediate introduction of the method appeared very necessary.

At a meeting of those manure manufacturers of South Germany chiefly interested, held at Mayence on Nov. 30th, 1885, and called at the instance of the experimental stations of Bonn, Darmstadt, Marburg, Speier, and Wiesbaden, I found myself called upon to report upon the work I had carried out and to apply to them to test my process as to what extent in the various laboratories concordant results could be obtained. In consequence of this request the meeting appointed representatives of four experimental stations and four manure works as a commission, which carefully drew average samples of 8 different phosphatic manures and distributed them amongst 12 laboratories, and at a further meeting held at Mayence, on December 19th, reported upon the results obtained.

From the returns furnished by 11 of the laboratories it was ascertained that the variations between the separate results and the mean averaged as follows:—

	Per cent "soluble" phosphoric acid.
With high-class superphosphate .. I.	= ± 0·27
,, ,, .. II.	= 0·38
With phosphorite ,, .. III.	= 0·30
,, ,, .. IV.	= 0·32
	Mean = ± 0·32

Against this the variations in the determinations of the phosphoric acid soluble in water made by the same chemists amounted to—

	Per cent phosphoric acid soluble in water.
With high-class superphosphate .. I.	= ± 0·39
,, ,, .. II.	= 0·36
With phosphorite ,, .. III.	= 0·13
,, ,, .. IV.	= 0·18
	Mean = ± 0·26

From this we see that the mean differences in the determinations of the "soluble" phosphoric acid exceed those of the phosphoric acid soluble in water by only 0·6 per cent. The representatives of the manure manufacturers and those of the experimental stations of Bonn, Darmstadt, Speier, and Wiesbaden have therefore agreed unanimously to accept this method for the analysis of all superphosphates from January, 1886, and in consequence thereof to advertise in their price lists a guaranteed percentage of "soluble" phosphoric acid in the different superphosphates.

In the case of Thomas precipitated phosphate the results obtained were not sufficiently concordant, and the commission was requested to look closer into the matter and to report again in due course.

It is now to be hoped that the convention which met at Mayence, as well as all other manure manufacturers and agricultural chemists, will co-operate in this movement, in order that through the instrumentality of this agreement this most desirable reform in the trade in precipitated or "reverted" phosphates may be carried out in the interests of buyers and sellers alike.

CERIUM OXIDE, YTTRIA, GLUCINA, AND AMMONIUM CHLORIDE IN DILUVIAL CLAY.

By Dr. J. H. STROHECKER.

At Hainstadt, not far from Seligenstadt, there extends a thick diluvial bed of clay, derived chiefly from syenite, the several layers of which differ remarkably even in their outward aspect. The two upper layers (I. and II. *a*) give the following composition:—

Layer I.

Silica	47·5444
Titanium oxide	traces
Alumina	24·5937
Glucina	6·4399
Ferric oxide	0·9190
Cerium hydroxide	13·4214
Lanthanum oxide	0·8576

Besides calcium sulphate and carbonate, magnesia, phosphoric acid, potassa, and soda.

Layer II. *a* showed—

Silica	58·3331
Alumina	11·7607
Glucina	5·3833
Ferric oxide	0·6356
Cerium hydroxide	9·4012
Didymia	0·8474
Lanthanum oxide	2·6536
Yttria	1·6949

Besides magnesia, phosphoric acid, lime, calcium sulphate, potassa, soda, ammonium chloride (0·0529 per cent), and lignite.

The ceria and yttria betray, as their origin, orthite, which occurs in the syenite at Weinheim in the Odenwalde. The high percentage of Ce_2O_3 allows an inference as to the abundance of this mineral in the original rock.

The stratum No. I. extends below arable soil over the entire Hainstadt clay deposit, and its colour is of different degrees of intensity in different places,—light flesh-colour, pale and dark cinnamon,—so that the colouring-matter, cerium hydroxide, must be variously plentiful in different parts. The bricks made from this clay are a pale orange-yellow (from cerium oxide) if lightly burnt; but if strongly burnt they are of a leather-colour, in contrast to the ordinary ferric-oxide bricks. It is known that Ce_2O_3 takes a leather-colour, or even a silver-grey at a white-heat.

The stratum No. II. is divided into two layers, *a* and *b*. The former is coloured black by lignite, and gives lemon-coloured bricks, since Ce_2O_3 is reduced by the carbon on ignition to Ce_3O_4. The bricks of *b* are orange-red to orange-yellow.

The blue stratum, No. III., contains cerium oxide, though in a smaller proportion than the fwo former, and yields bricks of a paler orange than II. *b*.

Didymium oxide has not yet been detected with certainty in No. I., either by the spectroscope or by chemical reactions, though rose-coloured spots in ignited masses of the clay indicate its presence. It is found along with yttria in II. *a*, whilst lanthanum oxide is found in both. The Hainstadt cerite-clays are characterised by their proportion of glucina, the almost constant companion of the cerite oxides. The precipitate of cerium hydroxide with

ammonia and soda has exactly the appearance of iron hydroxide, though in a finely-divided state it appears of a cinnamon-brown, inclining to orange. The similarity of the two precipitates is so great that cerium hydroxide has probably often been taken for ferric hydroxide, especially as the ferrocyanide precipitates of both are scarcely, if at all, distinguishable. Cerium is most easily recognised by the colour of its oxides, the orange-red Ce_2O_3, the lemon-coloured Ce_3O_4, the sky-blue compound of cerous oxide and potassium, by its precipitate with oxalic acid, the formation of cerium-ammonium chloride, and its solubility in caustic potassa. The three cerium oxides have been detected in the ash of plants as early as 1880.—*Journ. f. Prakt. Chemie* (1886, p. 132).

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING FEBRUARY 28TH, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, March 7th, 1886.

SIR,—We submit herewith the results of our analyses of the 163 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 28th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 163 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

The general character of the water supplied to the Metropolis during the month of February did not differ appreciably, in respect to the small proportion of organic matter habitually present, from that of the supply furnished now for some months past. Thus, the mean amount of organic carbon found in the Thames-derived supply for the month was 0·172 part in 100,000 parts of the water, as against a mean amount of 0·183 part in January, and of 0·170 part in December, corresponding to about three-tenths of a grain of organic matter per gallon.

The degree of colour-tint, somewhat in excess during the heavy floods of November, has since shown a steady continuous decrease. Moreover, since the period of these floods not a single daily sample has been met with to which even the expression "very slightly turbid" would apply; and this notwithstanding the exceptional and persistent low temperature of the last three months, a condition affecting appreciably the viscosity of the water, and in other ways impeding the processes of filtration.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

(Continued from p. 124.)

Influence of Proteid Matter on the Diastatic Action of Saliva in Neutral Solutions.

IT was formerly demonstrated by one of us† that the presence of 1 per cent peptone tended to increase the diastatic action of saliva in a neutral solution to such an extent that on an average about 4 per cent more starch was converted into sugar during 45 minutes at 40° C.; this with 25 c.c. of saliva in 100 c.c. of the digestive mixture. This effect we attributed to a direct stimulating action on the part of the proteid matter. Langley and Eves,‡ however, object to this conclusion, although they bring forward no facts to prove the contrary. Considering that litmus will not detect less than 0·001 per cent acid or alkali, they state that there may be in the neutralised fluid an excess of acid or alkali to this extent, and if, as may well be the case, ptyalin acts best in a neutral solution, the effect of the peptone might be due to its putting *hors de combat* the slight excess of acid or alkali which remains on apparent neutralisation. But, as Langley himself has shown, the proteid matter naturally present in 25 c.c. saliva, or even much less, is far more than sufficient to combine with and render inert any such amount of free acid or alkali. We see no other possible explanation of the action of peptones on the diastatic action of saliva in a neutral solution than a direct stimulation of the ferment. Moreover, Langley and Eves have found that when neutralised saliva is diluted a hundred times, peptone is still able to increase the rate at which it converts starch into sugar, from which they are forced to conclude that the small amount of acid or alkali which may be present, cannot exert, in such a dilution, any retarding influence. We present the following additional results confirmatory of our previous experiments.

In our present experiments we have, however, used much less saliva, and also smaller percentages of peptone.

SERIES XI.

20 c.c. of filtered saliva were neutralised, and then diluted to 100 c.c.

0·8 grm. of pure albumen-peptone was dissolved in water, made exactly neutral with Na_2CO_3, and the solution diluted to 100 c.c.

10 c.c. of the diluted saliva were employed in each digestion, and of the peptone solution quantities equivalent to 0·05, 0·1, and 0·2 grm. of peptone. Length of digestion, 30 minutes.

Per cent peptone.	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
0	0·0834 grm.	0·3400 grm.	30·61 p.c.
0·05	0·0875	0·3568	32·11
0·10	0·0868	0·3544	32·01
0·20	0·0873	0·3560	32·04

Here, with the smaller amount of ferment, the increase is not so great as with the larger quantity of saliva and with the longer period of digestion; still the amount of starch converted is increased on an average about 1·50 per cent. It is interesting to note that under these conditions the full effect of the proteid matter is produced by even 0·05 per cent. Langley and Eves found the maximum effect with saliva ten times diluted to be produced by about 0·1 per cent peptone. In our experiment, however, the dilution of the saliva in the digestive mixture is 1 : 50.

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.
† Chittenden and Ely, *Amer. Chem. Jour.*, iv., 107.
‡ *Journal of Physiology*, vol. iv., No. 1.

Influence af Proteid Matter on the Diastatic Action of Saliva in Alkaline Solutions.

It was previously demonstrated by one of us that the presence of 1 per cent peptone in a digestive mixture containing 25 per cent saliva and 0·3 and 0·15 per cent sodium carbonate respectively, tended to nearly double the diastatic action, bringing it up almost to the action of saliva unmixed with alkaline carbonate.

We give here a few additional experiments bearing on this point.

The very noticeable difference in the action of small percentages of sodium carbonate on the diastatic activity of moderately dilute and very dilute saliva at once suggests the possibility of some connection between the dilution and the reduced percentage of proteid matter. What, now, is the influence of small amounts of peptone on very weak alkaline solutions of saliva? We will give the results of one series of experiments in answer to this question.

SERIES XII.

20 c.c. of saliva with an alkalinity equal to 0·110 per cent sodium carbonate were diluted to 100 c.c.; 10 c.c. of the diluted saliva were used in each digestion of 100 c.c.; consequently the alkalinity of the digestive mixture was equal to 0·0022 per cent sodium carbonate. Neutral peptone was added in varying quantities. The mixtures were warmed at 40° C. for 30 minutes.

Per cent peptone.	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
0	0·0761 grm.	0·3104 grm.	27·94 p. c.
0·05	0·0823	0·3352	30·18
0·10	0·0841	0·3424	30·82
0·20	0·0853	0·3480	31·33

The same saliva neutralised converted 30·61 per cent of the starch into sugar; consequently the neutral peptone (0·2 per cent) caused the alkaline saliva to show a diastatic action considerably greater than the neutral saliva, but not equal in this case to the action of the same percentage of peptone on the neutralised saliva. Compare Series XI., made with the same saliva.

Still other experiments of the same nature have shown like results, and even more marked. Thus, while neutral saliva without peptone converted in one instance 18·16 per cent starch into sugar, a like quantity of the normally alkaline saliva (=0·002 per cent Na_2CO_3 in the digestive mixture) with 0·1 per cent peptone converted 31·90 per cent starch into sugar.

Increasing the percentage of carbonate to a point where previous experiment had shown almost complete stopping of the action of the ferment, it was found that 0·1 per cent of neutral peptone would, in the above dilution, bring the diastatic action up, almost to that of the neutral saliva.

SERIES XIII.

Thus 20 c.c. of saliva were neutralised and diluted to 100 c.c., 10 c.c. used in each digestion.

	0 Na_2CO_3 0 Peptone.	0·005 p c. Na_2CO_3 0 Peptone.	0·005 p.c. Na_2CO_3 0·10 p.c. Peptone.
Wt. Cu in 1-8th	0·0803 grm.	0·0181 grm.	0·0708 grm.
Total amt. sugar	0·3272	0·0800	0·2896
Starch converted	29·45 p. c.	7·20 p. c.	26·07 p.c.

With 0·025 and 0·050 per cent sodium carbonate, 0·1 per cent peptone availed but little: there was slight diastatic action, but not enough sugar formed to make the determination of it of any value. These results would seem to indicate that one action of the peptone in an alkaline solution is to combine with the alkaline carbonate and form a compound of quite different power: thus with 0·050 per cent sodium carbonate a corresponding larger percentage of peptone is required to increase the diastatic power. In addition to this action, however, there is still manifest the direct stimulating action of the proteid matter on the ferment; seen in one case in the increased percentage of sugar formed in the alkaline solution over the amount formed in neutral solution by the same saliva under like conditions.

As to the union of peptone and the alkaline carbonate we have a strong indication of a combination, in that the presence of peptone tends to diminish somewhat the destructive action of small percentages of sodium carbonate in diluted saliva.

Thus, while 10 c.c. of neutralised dilute saliva (1:5), warmed for one hour with 0·05 per cent sodium carbonate, converted after neutralisation 25·05 per cent starch into sugar, the same amount of saliva warmed for the same length of time with the same percentage of sodium carbonate, plus 0·4 per cent peptone, converted after neutralisation 32·68 per cent of the starch.

The peptone present had evidently in some way prevented the destructive action of the alkaline carbonate, and the most plausible explanation seems to be the probable formation of an alkaline proteid body.

(To be continued.)

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 126.)

MR. GLADDING read the following paper, which was ordered to be spread upon the minutes:—

"*On the Determination of Citrate-soluble Phosphoric Acid in Natural Guanos.*" By THOMAS GLADDING, A.M.

In the method adopted by the Association of Official Agricultural Chemists, at Philadelphia, 1884, for the estimation of the reverted or citrate-soluble P_2O_5 in superphosphates, 2 grms. of the fertiliser are digested with 100 c.c. of the solvent.

This amount of solvent is regarded as ample for the solution of all strictly precipitated P_2O_5 that may be present. It undoubtedly at the same time dissolves a considerable portion of the strictly insoluble P_2O_5 that is contained in the superphosphate; but this is unavoidable, and, as all superphosphates are treated exactly alike, no injustice is done by this course.

The agricultural chemist is frequently called upon, however, to determine the so-called available or citrate-soluble phosphoric acid in the many natural guanos that are in the market. These guanos have not been treated with acid, and do not contain, strictly speaking, any reverted phosphate. What, then, it may be asked, is the object of determining the citrate-soluble in these forms of fertiliser? Obviously there is only one object, and that is to determine their degree of solubility as compared with one another and with artificially treated manures.

In determining the citrate-soluble P_2O_5 in this form of fertiliser, the Association has not distinctly stated the amount of fertiliser that must be used to every 100 c.c. of citrate solution. In consequence considerable latitude is exercised at the present time in this direction, some analysts employing 2 grms. to 100 c.c. solvent, while others use the much smaller quantity of 0·4 grm. to 100 c.c. solvent, causing thereby much confusion and dissatisfaction.

The object of determining the available or citrate-soluble in these natural guanos is, as has been said, to furnish a means of comparison as to their relative solubility. Thus in my paper "On the Reversion of Phosphoric Acid" (*Am. Chem. Journal*, vol. vi., No. 1) I found that by treating several guanos in the same way exactly (2 grms to 100 c.c. cit. sol.) I obtained, as citrate-soluble, respectively—

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

Oruba guano	2·09 per cent.
Orchilla guano	4·81 ,,
Mona Island guano	6·82 ,,
Peruvian guano	13·14 ,,

This gives us at once a rough comparison of these guanos. Peruvian, for instance, is at least six times more easily soluble than Oruba guano.

Right here arises a strong objection to the use of 0·4 grm. to 100 c.c. solvent, or rather two objections.

First. In the above tests all but a trace of the Peruvian guano was dissolved. Now had I used 0·4 grm. of each my results on the Peruvian would consequently be the same as above, for I could not dissolve out more than there is present, while the Orchilla would have come up to the same amount at least as the Peruvian, if not more, and the Oruba would probably give at least 6 or 7 per cent. As a result all sense of comparison would be lost, and the comparative test be valueless. We may lay it down as an axiom—*A unit of comparison must not be greater than any one of the objects compared.*

Second. In the second place these guanos will inevitably be compared with superphosphates. Thus a large lot of Orchilla guano, tested by using 0·4 grm. to 100 c.c. citrate-solution, gave total P_2O_5 16·42; available or citrate-solution 13·05 per cent. An acid phosphate analysed at the same time was reported as containing total P_2O_5 14·59; available, 10·94. Comparing these reports side by side we have—

	Acid phosphate.	Guano.
Total P_2O_5 ..	14·59 per cent.	16·42 per cent.
Available ..	10·94 ,,	13·05 ,,
Insoluble ..	3·65 ,,	3·37 ,,

In other words, the guano is a far more valuable article than the acid phosphate,—a most erroneous conclusion.

But a direct argument for the use of 0·4 grm. of these guanos to 100 c.c. solvent is made as follows:—

Manufacturers mix these guanos with superphosphates in very small proportions, say 10 and 20 per cent. When, therefore, 2 grms. of such mixture is digested with 100 c.c. solvent we are employing only 0·2 and 0·4 grm. of the guano, respectively, to 100 c.c. citrate-solution. A much larger amount is dissolved than when 2 grms. are used to 100 c.c. Consequently, when analysing the guano before mixing with the acid phosphate, the same amount, 0·4 grm., should be taken.

In answer to this argument, it is true that where 0·4 grm. of such a guano is digested alone with 100 c.c. citrate-solution a very much larger percentage of P_2O_5 is dissolved than when 2 grms. are thus treated. But when this 0·4 grm. is mixed with 1·6 grms. of a superphosphate there remains, after washing out the soluble, a large amount of reverted and insoluble phosphates, as also a large amount of $CaSO_4$, organic matter, &c. Now in the presence of these foreign matters we have found that the action of the citrate on the $\frac{1}{5}$ grm. of admixed guano is greatly weakened, and is very nearly represented by the action on the 2 grms. of guano when treated alone with 100 c.c. solution. For some years our firm has analysed Orchillas, Curaçaos, &c., for available, using 2 grms. and 100 c.c. for manufacturers. The mixtures of these guanos with acid phosphates have analysed almost exactly what was expected by calculation from the analyses of the component parts.

To convince ourselves, however, on this point, we have taken a sample of Orchilla guano, mixed it with a superphosphate, and analysed mixture, with the following results:—

Analysis of Superphosphate.

(2 grms. to 100 c.c. cit.-sol.)

Total P_2O_5	11·55 p. c.
Available P_2O_5	9·75
Insoluble P_2O_5	1·80

(First mixture.)

1·8 grms. superphosphate.
0·2 grm. guano = 10 per cent guano.
Insoluble obtained, 3·00 per cent.

Analysis of Guano.

	(2 grms. to 100 c.c.)	(4 grms. to 100 c.c.)
Total P_2O_5 ..	16·42 p. c.	16·42 p. c.
Available P_2O_5	5·87	13·05
Insoluble P_2O_5	10·55	3·37

(Second mixture.)

1·6 grms. superphosphate.
0·4 grm. guano = 20 per cent guano.
3·88 per cent.

Calculating the theoretical results from analyses of components:—

(1) When 2 grms. guano were used to 100 c.c.:—

(First mixture.)

	Per cent.		Per cent.
1·8 grms. superphosphate	× 1·8	insoluble	0·0324 grm.
0·2 grm. guano	× 10·55	insoluble	0·0210
			2) 0·0534
			2·67

(Second mixture.)

	Per cent.		Per cent.
1·6 grms. superphosphate	× 1·8	insoluble	0·0288 grm.
0·4 grm. superphosphate	× 10·55	insoluble	0·0420
			2) 0·0708
			3·54

That is, the insolubles actually obtained were 0·23 per cent, and 0·34 per cent higher than they should have been by calculation, thus showing that the availables in the guano were rather above than under the truth.

(2) When 0·4 grm. guano was used to 100 c.c.:—

(First mixture.)

	Per cent.		
1·8 grms. superphosphate	× 1·8	.. ..	0·0324
0·2 grm. guano	× 3·37	.. ..	0·0067
			2) 0·0391
			1·95

(Second mixture.)

	Per cent.		
1·6 grms. superphosphate	× 1·8	.. ..	0·0288
0·4 grm. guano	× 3·37	.. ..	0·0134
			2) 0·0422
			2·11

If we had reported this guano to the manufacturer as containing 13·35 per cent available, 3·37 per cent insoluble, he would have calculated on getting these last figures on his mixtures, viz., 1·95 and 2·11 per cent. When on analysis his mixtures actually returned 3 per cent, and 3·54 per cent insoluble, an explanation would be in order. The above analyses were made just at the time of mixture. A mixture of 10 per cent guano and 90 per cent superphosphate was allowed to stand four days. The sample was then analysed, and even ground to a fine paste, instead of using a rubber pestle, as usual, so as to obtain as low an insoluble as possible. The analysis gave insoluble 2·80 per cent.

In conclusion, we believe the only just and safe course to be the employment in all cases of the same standard of measurement, the use of 2 grms. of all classes of fertilisers to 100 c.c. of citrate solution.

To avoid difficulties arising from washing we use the following method:—After digesting 30° minutes at 65° C. the flask is filled to the mark with water, cooled quickly, filtered till perfectly clear, an aliquot evaporated to dryness, ignited with magnesium nitrate to P_2O_5, estimated as usual. The reverted in superphosphates might be determined directly in the same way.

Laboratory of Stillwell and Gladding.

By consent of the Association Prof. W. C. Stubbs read the following paper, by Mr. B. B. Ross, an assistant-chemist in the laboratory of the Alabama State Chemist, and it was ordered to be spread upon the minutes.

"*Method of Determining Citrate-Soluble Phosphoric Acid by Elimination of Citric Acid.*" By B. B. Ross, Assistant in State Laboratory, A. and M. College, Auburn, Ala.

This method depends upon the precipitation of citric acid in neutral solutions by addition of calcium chloride, the solution being heated nearly to boiling in order to render the precipitate insoluble in the ammonium chloride formed. In the determination of citrate-soluble phosphoric acid by this method, the method adopted by the Association is followed as far as the filtration of the ammonium citrate solution, in which the residue from the treatment with water has been digested for half an hour at 65° C.

The following scheme of analysis was followed in arriving at the appended results:—

Carefully collect the filtrate and washings resulting from the ammonium citrate treatment; transfer to a cylinder, and dilute to 200 c.c.; mix well.

Take 50 c.c. and dilute to about 100 c.c.; add calcium chloride solution in excess, and heat nearly to boiling, stirring vigorously all the while after the solution begins to cloud; apply the heat very cautiously towards the last, and continue stirring assiduously until a copious white precipitate of calcium citrate is formed and well coagulated. The precipitate will subside immediately. Filter; wash well with very hot water, first by decantation and afterwards on the filter. To the filtrate add ammoniac hydrate in very slight excess; add 15 grms. of dry ammonium nitrate, and precipitate the phosphoric acid with molybdic solution. Proceed as with total phosphoric acid.

Calcium chloride solution: this is a neutral 20 per cent solution of calcium chloride.

It may be necessary to take an aliquot representing more than one-half grm. on account of a small percentage of citrate-soluble being present in the substance (less than 2 per cent), thus necessitating the addition of a larger quantity of calcium chloride. The calcium citrate precipitate is somewhat bulky, but if large filters are used it will not prove too unwieldy, and can be filtered and washed with great facility.

This process consumes very little time, and precipitation of the phosphoric acid with the molybdic solution can be accomplished within fifteen minutes after measuring an aliquot part of the filtrate obtained by treatment with ammonium citrate. Several experimental analyses of fertilisers have been made by this method, and all tests made by the above scheme have resulted satisfactorily. However, the limited amount of time employed in the examination of the subject has precluded a thorough investigation.

The following samples were subjected to analysis, and the results given below verified by additional tests.—

No. 1. South Carolina phosphate, sent by Prof. Jenkins for the purpose of testing the Association method.

No. 2. Navassa phosphate, also from Prof. Jenkins. In this sample, as shown by duplicate determinations, a portion of the phosphoric acid has reverted since our analysis was made last fall.

No. 3. Complete guano.

No. 4. Complete guano.

No. 5. Alabama phosphate rock.

No. 6. Phosphate containing a large percentage of citrate-soluble phosphoric acid.

(To be continued.)

Table of Results.

	1.	2.	3.	4.	5.	6.
Total phosphoric acid—	15·15	16·72	11·90	13·06	28·16	19·77
Soluble phosphoric acid—	11·71	5·60	8·54	5·76	—	—
Insoluble phosphoric acid—	1·15	5·48	1·09	3·46	25·84	2·21
Citrate-soluble by difference—	2·29	5·64	2·27	3·84	2·32	17·56
Citrate-soluble by actual determination—	2·30	5·76	2·21	3·77	2·43	17·35

THIRD REPORT OF THE COMMITTEE*

RE-APPOINTED FOR THE PURPOSE OF DRAWING UP A STATEMENT OF THE

VARIETIES OF CHEMICAL NAMES WHICH HAVE COME INTO USE,

FOR INDICATING THE CAUSES WHICH HAVE LED TO THEIR ADOPTION, AND FOR CONSIDERING WHAT CAN BE DONE TO BRING ABOUT SOME CONVERGENCE OF THE VIEWS ON CHEMICAL NOMENCLATURE OBTAINING AMONG ENGLISH AND FOREIGN CHEMISTS.†

(Continued from p. 127).

X.

1. —
2. Subnitrate of bismuth.
3. Subnitrate of bismuth.
4. —
5. Tetartonitrate of bismuth.
6. Hydrated subnitrate of bismuth.
7. —
8. Hydrated subnitrate of bismuth.
9. Subnitrate of bismuth (HO,NO_5+3BiO).
10. Salpetersaures Wismuthoxyd, einfach. Basisch salpetersaures Wismuthoxyd (BiO_3,NO_5+Aq).
11. Basisch salpetersaures Wismuthoxyd; Bismuthum Subnitricum ($N_2O_5,BiO+3BiO,AqN_2O_5,BiO+2BiO$).
12. Verbindung von salpetersaurem Wismuthoxyd, mit Wismuthoxydhydrat ($\dot{\overline{Bi}}\overline{N}+3\dot{Bi}\dot{H}$).
13. Basisch salpetersaures Wismuthoxyd, drittelsaures salpetersaures Wismuthoxyd.
14. Basisch salpetersaures Wismuth.
15. A basic salt (BiO_3+NO_5).
16. Subnitrate of bismuth (BiO_3,NO_5+HO).
17. Sous-azotate de bismuth.
18. Basic nitrate of teroxide of bismuth BiO_3,NO_5+2HO).
19. Drittelsaures Salz (BiO_3NO_5+2HO), Bisoxynitrat ($2(BiO_3,3HO)BiO_3,3NO_5$).
20. Subnitrate of bismuth ($9HO,4NO_5,+5BiO_3$).
21. Sous-azotate de bismuth.
22. —
23. A basic nitrate ($BiNO_4,H_2O$ or $Bi_2O_3,N_2O_5,2H_2O$).
24. Sous-azotate.
25. —
26. Basic nitrate ($Bi_2O_3,N_2O_5,2OH_2$, or $Bi'''(NO_3)_3,Bi_2O_3,3OH_2$).
27. —
28. Azotate basique de bismuth ($Bi'''(AzO_4)+H_2O$ or $(BiO)AzO_3+H_2O$.
29. Basic nitrate of bismuth, also called trisnitrate of bismuth (Bi_2O_3,N_2O_5,H_2O).
30. Wismuthnitrat. $Bi(ONO_2)(OH)_2$.
31. Basisches salpetersaures Wismuthoxyd $\begin{pmatrix}NO_2\\H_2\end{pmatrix}O_3Bi$ or $NO_2OBiO+H_2O$).
32. Basic nitrate (see 26).

* Consisting of Professors Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary), and V. H. Veley.

† Read at the British Association, Aberdeen Meeting, Section D.

33. Bismuthous subnitrate ($Bi_2O_3,2HNO_3$).
34. Basic bismuth nitrate, $Bi(OH)_2NO_3$.
35. Bismuthous nitrate dihydrate, $NO_2(Bi''Ho_2O)$.
36. Basic bismuth nitrate, $Bi(OH)_2NO_3$.

XI.

1. —
2. —
3. —
4. —
5. A sub-salt.
6. A compound of oxide of bismuth with chloride.
7. —
8. (See 6.)
9. A sub-salt ($BiCl+2BiO+HO$).
10. Wismuthoxyd-chlorwismuth. Wismuthoxychlorür. Basisch salzsaures Wismuthoxyd ($BiCl_3,2BiO_3$).
11. Basisches Salz.
12. ($BiCl+2\dot{B}i\dot{H}$.)
13. Wismuth bisoxychlorid. Zweifach-basisches Wismuth Chlorid (Bi_2ClO_2 oder $Bi_2Cl_3+Bi_2O_3$).
14. —
15. Oxychloride of bismuth ($BiCl_3+2BiO_3+3HO$).
16. Oxychloride of bismuth ($BiCl_32BiO_3$).
17. Oxychlorure de bismuth ($Bi_2Cl_3+2(Bi_2O_3+3HO)$.
18. —
19. Bisoxychlorid, zweifach basisches Salz ($2BiO_3,BiCl_3$).
20. Oxychloride of bismuth ($BiCl_3,2BiO_3$).
21. (See 17.)
22. —
23. Oxychloride of bismuth (BiOCl), 1863. Bismuthyl chloride (BiOCl), 1879. Supp. III.
24. Oxychlorure (BiOCl).
25. Basisches Clorwismuth.
26. Oxychloride (BiClO).
27. Bismuth oxychloride (BiOCl).
28. Oxychlorure de bismuth (BiOCl or $Bi_2O_3,BiCl_3$).
29. Oxychloride of bismuth, $2(BiCl_3Bi_2O_3),H_2O$.
30. Wismuthoxychlorür.
31. Basisches Chlorwismuth, Wismuthoxychlorid (BiOCl).
32. Oxychloride (BiClO).
33. Bismuthous Oxychloride, $2(BiCl_3Bi_2O_3),OH_2$ or BiOCl.
34. Bismuth oxychloride (BiOCl).
35. Bismuthous oxychloride (BiOCl).
36. Basic bismuth chloride. (Bismuth oxychloride).

XII.

1. Oxysulphat of mercury.
2. Suboxysulphate of mercury.
3. Neutral persulphate of mercury.
4. Suboxysulphate of mercury.
5. Disulphate of mercury.
6. A sub-salt.
7. —
8. A sub-salt.
9. ($HgO.SO_3+2HgO$).
10. Schwefelsaures Quecksilberoxyd, Drittel ($3HgO.SO_3$).
11. Basisches schwefelsaures Quecksilberoxyd ($3HgO.SO_3$).
12. Basisches schwefelsaures Quecksilberoxyd.
13. Basisch schwefelsaures Quecksilberoxyd ($3HgO.SO_3$).
14. Basisches schwefelsaures Quecksilberoxyd.
15. Basic sulphate ($3HgO+SO_3$).
16. Sub-sulphate.
17. Sel basique ($3HgO.SO^s$).
18. A basic salt ($3HgO.SO_3$).
19. Drittelsaures Salz ($3HgO.SO_3$).
20. A sub-salt ($3HgO.SO_3$).
21. Sel basique ($3HgO.SO^s$).
22. —
23. Basic sulphate of mercury $(3HgO.SO_3 = HgSO_4.2HgO$.
24. Sel basique $\left(\begin{matrix}SO^{s''}\\Hg\\Hg\\Hg\end{matrix}\right\}\begin{matrix}O\\O\end{matrix}\Big)''\Big\}O^s$
25. —
26. A basic salt ($3HgO.SO_3$).
27. A basic salt (Hg_3SO_6).
28. Sulfate trimercurique ($SO_4Hg,2HgO$).
29. A basic sulphate ($HgO.SO_3.2HgO$).
30. Drittelgesättigtes Mercuridsulfat.
31. Basisches Salz ($SO_2O_2Hg+2HgO$).
32. A basic salt ($3HgO.SO_3$).
33. A basic salt ($HgSO_4.2HgO$).
34. A basic salt (Hg_3SO_6).
35. Trimercuric sulphate ($SHgo_3$).
36. Basic sulphate ($SO_2.O_2Hg+2HgO$).

XIII.

1. —
2. —
3. —
4. —
5. —
6. —
7. —
8. Chlorosulphuret of mercury ($hg+2C)+2(hg+2S$).
9. Chloride and sulphuret of mercury ($HgCl+2HgS$).
10. Chlorquecksilber-, Schwefelquecksilber, oder Chlor- und Schwefelquecksilber ($2HgS,HgCl$).
11. Schwefelbasisches Quecksilberchlorid (Berzelius's nomenclature) ($HgCl_2+2HgS$).
12. Quecksilberschwefelchlorid ($HgCl,+2HgS$).
13. —
14. —
15. Chlorosulphuret ($HgCl+2HgS$).
16. Sulphochloride of mercury ($HgCl,2HgS$).
17. $HgCl+2HgS$.
18. —
19. Quecksilbersulphuretochlorid (Quecksilberchlorosulphuret) ($2HgS,HgCl$).
20. —
21. (See No. 17).
22. —
23. Sulphochloride of mercury ($Hg_3S_2Cl_2$).
24. —
25. —
26. —
27. Mercuric sulphochloride ($Hg_3S_2Cl_2$).
28. Sulfochlorure mercurique ($2HgS,HgCl_2$).
29. Chlorosulphide of Mercury ($HgCl_22HgS$).
30. Mercuridthiochlorür.
31. —
32. —
33. —
34. ($2HgS,HgCl_2$).
35. Trimercuric Disulphodichloride $\left(\begin{matrix}HgCl\\HgCl\end{matrix}\right.\begin{matrix}''\\Hg_s\end{matrix}\Big)$
36. —

(To be continued).

Brooke, Simpson, and Spiller, Limited.—The firm of Brooke, Simpson, and Spiller, well known doubtless to most of our readers as having been for many years the largest manufacturers of alkaline colours in the United Kingdom, has been converted into a limited liability company. The share capital is £150,000 in 30,000 shares of £5 each. The former partners in the firm will join the Board of the new Company, and Mr. A. Brooke will act as managing director. As a proof that in spite of the imperfection of our patent laws coal-tar colours may be successfully manufactured in Britain we may mention that, according to the accountant's report, the profits made by the late firm from 1877 to the end of 1885 would have allowed of an annual dividend of 12 per cent upon the total share capital.

NOTICES OF BOOKS.

The Chemistry of the Coal-Tar Colours (Technological Handbooks). Translated from the German by Dr. R. BENEDIKT, and Edited, with Additions, by E. KNECHT, Ph.D., Head Master of the Dyeing Department of the Technical College, Bradford, Editor of the *Journal of the Society of Dyers and Colourists*. London: G. Bell and Sons.

WE have here a most valuable addition to English technical literature. We have no recent work which gives a comprehensive survey of this rich and apparently inexhaustible department of industrial chemistry.

The book opens with a brief historical account of the principal discoveries and inventions in this field, which may be said to have originated with the detection by Garden, in 1820, of naphthalene as a constituent in coal-tar.

In the first chapter the author treats of the optical properties of colouring-matters, the decomposition of light by the prism, the absorption-spectra of organic colouring-matters, fluorescence, and on the spectroscope as a means of detecting colouring-matters. There is here sound instruction on a subject too much neglected by many dyers and colourists. The views here laid down on primary colours are peculiar. Newton and his disciples, including one of the most eminent authorities on colours, Prof. Chevreul, recognise three primary colours, red, yellow, and blue; Young and Fresnel, with their numerous and distinguished followers, regard as primary colours red, green, and violet; and Dr. Benedikt differs from both parties by adopting four primary colours, red, yellow, green, and blue. Spectrum analysis the author considers as "only of minor importance to the colour chemist." We next find an account of the general chemical properties of the colouring-matters; an account of chromophorous and salt-forming groups; a classification of artificial colouring-matters according as they are basic, acid (including the sulphones), or neutral.

The methods of dissolving the colours are next taken into consideration—a process in which a few years ago, if not at present, grave errors were often committed. Dr. Benedikt very rightly recommends that methylated spirits used should be free from impurities, especially aldehyd and acetone, which act very injuriously on certain dyes. But to follow this good advice is not very easy in England, since the Inland Revenue does not allow methylated spirit, or even mere wood-spirit (methylic alcohol), to be sold duty free if the purification has been carried beyond a certain degree. Hence colours soluble in other media are preferable for use in this country.

In proceeding to dyeing, properly speaking, Dr. Benedikt gives an account of the chemical properties of the three principal fibres, silk, wool, and cotton, and considers the relations of these fibres to colouring-matters, substantive dyeing, adjective dyeing with mordants, the metallic hydrates, sulphur, metallic sulphides, silica, double cyanides, the oil mordants, soaps, tannin mordants, albuminous and gelatinous substances, fast and loose colours, testing colouring-matters, comparative dye-trials, colorimetry, and impurities in colouring-matters.

Part II. is devoted to coal-tar and to such of its constituents as have been found eminently useful in colour-making, *i. e.*, benzene, toluene, the xylenes, naphthalene, anthracene, and phenol.

In Part III. we find a classification of the coal-tar colours into the anilines, the phenols, the azos, and the anthracenes, each of them subdivided into several groups. The various colours are then made the subject of special treatment, including the composition, the constitution, and the synonyms of each, its uses, and the principles of its preparation.

This work will be valuable not merely to dyers, printers, colour-manufacturers, and technical students, but, in virtue of its great clearness, we can recommend it to all young chemists who are grappling with the organic department of the science. All such will find its thorough study an excellent discipline, even if they have no intention of concerning themselves with any branch of the tinctorial art.

CORRESPONDENCE.

ESTIMATION OF MAGNESIUM.

To the Editor of the Chemical News.

SIR.—Allow me to add my testimony to the value of a modification in the method of precipitating ammonium magnesium phosphate described in your issue of Feb. 26, 1886, by Mr. Lawrence Briant, F.C.S., (CHEM. NEWS, vol. liii., p. 99). This modification has been in use in my laboratory since 1880. The experimental tests were executed for me by my late pupil, Mr. W. P. Gibbs, now chemist to Messrs. Newton, Keates, and Co., St. Helens, and I communicated the idea to Dr. Voelcker in a private letter some time about May, 1881.—I am, &c.,

W. F. K. STOCK.

Darlington, March 10, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cii., No. 2, March 1, 1886.

On the Spectra of Erbia.—W. Crookes.—For the contents of this paper see CHEMICAL NEWS, vol. liii., p. 75.

Crystallisation of Sodium and Ammonium Paratartrate.—J. Joubert.—With reference to M. Bichat's communication in the *Comptes Rendus* for Feb. 22 last, the author describes the method which he used about ten years ago for the same purposes in M. Pasteur's laboratory. This method consists in passing, with all the precautions necessary for keeping out atmospheric dust, a continuous current of dry air over the surface of the solution of the salt. In this manner are obtained fine crystals of paratartrate without hemihedric facets.

Isomeric States of Chromium Sesquichloride (Green Sesquichloride).—A. Recoura.—The author applies thermo-chemical methods to the study of the isomeric states of this chloride. He concludes that the totality of his experiments forms a cycle in which by setting out from the green solution we arrive at a violet solution. The violet solution is a definite state.

Certain Proximate Principles of the Bark of Bitter Orange.—M. Tanret.—The author isolates and distinguishes a weak acid, $C_{44}H_{28}O_{14}$; a non-crystalline body excessively bitter, and which does not yield glucose on treatment with acids; a glucoside, isohesperidine; a bitter principle, aurantiamarine, which is a glucoside, and hesperidine in the form of a white powder.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin Vol. xix., No. 1.

Action of Acetyl Chloride upon Pyridine.—M. Dennstedt and J. Zimmermann.—The authors have not succeeded in obtaining dehydracetic acid from acetyl-chloride, either by passing its vapours at different tempera-

tures through glass or iron tubes, or by heating it alone in a closed tube, or by heating with lead oxide.

On Conessine.—K. Polstorff and P. Schirmer.—Conessine, $C_{12}H_{20}N$, crystallises in tender silky needles. When dried it forms a loose mass, of a dazzling whiteness, fusible at 121·5. It is sparingly soluble in water, but very readily in alcohol, ether, chloroform, and benzol. The most dilute solution of its hydrochlorate gives a red-brown precipitate with an iodised solution of potassium iodide.

On Acid Diphenylether and some of its Derivations.—A. Rössing.—Not adapted for useful abstraction.

Do the Statical and Dynamical Methods of Determining Vapour Tension give Different Results? A Reply to G. W. A. Kahlbaum's Answer.—W. Ramsay and S. Young.—This paper would require to be accompanied by the accompanying tables and diagram.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Part 1 and 2.

Researches on Isatoic Acid and its Derivatives.—This investigation includes a number of memoirs describing reserches executed in the laboratory of the editor, Prof. E. von Meyer, with his co-operation or under his supervision. Isatoic acid, discovered by the late Prof. H. Kolbe, is identical with anthranil carbonic acid. The following are the memoirs in question:—

I. **On Isatoic Acid.**—E. von Meyer and Th. Bellmann.—This paper describes the behaviour of isatoic acid with benzoylchloride, hydroxylamin, phenylhydrazin, formic hydrate, phosphorus pentachloride, and calcium hypochlorite; the identity of isatoic acid and anthranilcarbonic acid is demonstrated. Acetylisatin is shown to be a compound not analogous to isatin in its constitution.

II. **On the Haloid Derivatives of Isatoic Acid.**—R. Dorsch.—The author has examined the behaviour of bromine with isatoic acid; the behaviour of monobrom-isatoic acid with hydrochloric acid and ammonia; the action of bromine upon nitro-isatoic acid; the action of chlorine upon isatoic acid; the oxidation of the haloid derivatives of isatin to the corresponding ones of isatoic acid; and in particular the oxidation of monobrom-isatin to monobrom-isatoic acid; the oxidation of dibrom-isatin to dibrom-isatoic acid; the behaviour of the latter with hydrochloric acid and ammonia; the oxidation of monochlor-isatin and dichlor-isatin respectively to mono- and dichlor-isatoic acids; and the behaviour of these with hydrochloric acid and ammonia, and an account of nitrobrom-isatin. Lastly, the author discusses the function of the halogens in the above-named compounds.

III. **On Paramethyl-isatoic Acid and certain Derivatives of Paramethyl-isatin.**—W. Panaotovic.—From the experiments here described it appears that paramethyl-isatin is quite analogous in its chemical behaviour to isatin. Hence paramethyl-isatoic acid must be regarded as paramethyl-anthranil-carbonic acid.

Part 3.

Sulphuretted Substitution-Derivatives of Butyric, Isobutyric, and Isovalerianic Acids.—J. M. Löven.—Just as the sulphides of the alcohol radicals can be oxidised to sulphones, sulpho-substituted fatty acids (sulphide-dicarbonic acids) can be transformed into sulphuryl-substituted (sulphon-dicarbonic) acids. In the ethers of these sulphone-acids each two atoms of hydrogen can be replaced. The acids thus arising by the introduction of alcohol-radicals are constituted symmetrically and are identical with the compounds formed by oxidation from sulpho-substituted fatty acids.

On Cyanuric, Di-, and Tri-thiocyanuric Acids.—Peter Klason.—Trithionic acid falls from very dilute solutions in short microscopic prisms of a faint yellowish colour. If precipitated from concentrated solutions it is amorphous and almost white. If boiled with water traces of it pass into sulpho-cyanogen. The author describes the potassium, barium, strontium, and calcium salts of this acid. Dithiocyanuric acid is distinguished from the tri-acid by the circumstance that in it an atom of oxygen is substituted for an atom of sulphur. Whilst trithionic acid belongs to the hydrosulphates, cyanuric acid must be regarded as an oxy-compound.

Cerium Oxide, Yttria, Glucina, and Ammonium Chloride in Diluvial Clays.—Dr. J. R. Strohecker.—(See p. 136).

Contributions to the Chemistry of Sea-Water.—Axel. Hamberg.—An examination of the relations between the sulphates and the chlorides in sea-water.

On Tetra-chlor-thio-pentetrachloride.—C. Willgerodt.—This compound melts without decomposition at 215°, and congeals at a few degrees lower. At 100° it becomes soft and pastey. It has a sharp, penetrating, but not unpleasant, odour. It dissolves freely in chloroform, ether, benzol, carbon disulphate, glacial acetic acid, and alcohol, and appears to sublime undecomposed.

The Preparation of Mono-nitro-anisoles, and Mono-nitro-phenetoles according to Kolbe's Method.—C. Willgerodt and M. Ferko.—The authors have succeeded in obtaining paranitro-anisol and paranitro-phenetol by this method in extraordinary purity. The melting-point of the former is not 51°, but 54°, and that of paranitrol-phenetol not 57° to 58°, but 60°. The corresponding ortho-compounds were obtained in the form of oils.

On certain Aromatic Iodide-Chlorides.—C. Willgerodt.—An account of phenyl-iodide-chloride, para-brom-phenyl-iodide-chloride, symmetric α-tribrom-phenyl-iodide-chloride, and paranitro-phenyl-iodide-chloride.

Part 4.

Communications from the Chemical Laboratory of the University of Leipzig.—E. von Meyer.—This consists of a memoir by M. Striegler on melanurenic acid. The principal results are that melanurenic acid forms well characterised salts both with acids and alkalies, the former of which are of little permanence. The acid character is therefore more decided than the basic properties of melanurenic acid. It is bibasic, and has probably the composition $C_6H_8N_8O_4$. With phosphorus pentachloride it forms phosphorus oxychloride and cyanuric chloride. With other reagents it is indifferent.

Contributions to the Knowledge of the Aromatic Ketones.—Karl Elbs.—In this memoir the author studies the processes for preparing the homologues of benzophenon, the reduction of aromatic ketones to secondary alcohols, the preparation of the β-pinacolines, and the synthesis of anthracenes from from aromatic ketones by splitting off water.

On certain Derivatives of Sulphurea.—G. McGowan.—The author has examined the behaviour of disulphurea dichloride with dilute nitric acid, the action of iodine chlorides upon sulphurea, and the action of potassium iodide upon disulphurea dichloride.

Researches from the Chemical Laboratory of Prof. Saytzeff at Kasan.—These consist of a paper by A. Tschebotareff and Al Saytzeff, on the reaction of ethyl-iodide upon zinc and butyrone, and the synthesis of ethyl-dipropyl carbinol; and a memoir by Gortaloff and Al. Saytzeff, on the reaction of methyl iodide and zinc upon butyrone, with the synthesis of methyl-dipropyl carbinol.

On New Compounds of Rhodium.—C. Vincent.—From the *Comptes Rendus*.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 3, February 1, 1886.

Analysis of the Juices of Mulberries.—E. Falières.—This analysis refers not to the fruit but to commercial juices and syrups.

Study on Milk in the Paris Hospitals and on an Apparatus for its Preservation.—Dr. Adam.—The author denies the constancy of the composition of milk, which few, if any, authorities have asserted. The preservative apparatus cannot be described intelligibly without the accompanying figures.

Microscopic Search for Foreign Pulps in Preserved Tomatoes.—P. Famel.—This paper requires the accompanying illustrations.

Seven Cases of Poisoning by Preserved Tomatoes.—F. Doggett.—Three of these cases are due to stannous chloride and four to a salt of lead.

Researches on the Dangers of the Aniline Colours.—L. Poincarré.—The author gives a table showing the mean time in which doses of aniline colours (and of the crude materials from which they are derived) required to prove fatal:—Binitrobenzol, one day; picric acid, violet (?), dimethylaniline, safranine, four days; binitrotoluol and orthotoluidine, five days; magenta, chrysoidine, paratoluidine, and green (?), seven days; resorcine, eight days; toluol, nine days; naphthylamine, ten days; naphthol, diphenylamine, acetanilide, eleven days; phthalic acid, thirteen; and Hofmann's violet, twenty-two days. The mean dose which had been taken up to the time of death was:—Phthalic acid, diphenylamine, paratoluidine, and acetanilide, 1 grm.; naphthylamine and resorcine, 0·8; chrysoidine, 0·7; magenta and "green," 0·6; binitrotoluol, 0·4; violet, 0·3; Hofmann's violet, binitrobenzol, safranine, toluidine, orthotoluidine, and picric acid, 0·1 grm. The author remarks that the products used were free from mercury, &c. (It must be noted that he does not state what proportion the fatal dose bears to the living weight of the animal, and that his results do not agree well with those of other observers.)

Microscopic Organisms in the Air of the Sea.—MM. Moreau and Miquel.—The air of the sea taken at a great distance from land, or even on the shore and in ports when the wind blows from the open, is in an almost perfect state of purity. Near continents the land-winds drive before them an atmosphere always impure, but at 100 kilometres from the coasts this impurity has disappeared. The sea rapidly purifies the pestilential atmosphere of continents; hence every expanse of water of a certain breadth becomes an absolute obstacle to the propagation of epidemics. Marine atmospheres driven upon land purify sensibly the air of the regions which they traverse; this purification can be recognised as far as Paris.

The sea is the tomb of moulds and of aërial schizophytes.

MEETINGS FOR THE WEEK.

MONDAY, 22nd.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Petroleum and its Products," by Boverton Redwood, F.C.S.
TUESDAY, 23rd.—Institution of Civil Engineers, 8
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
—— Royal Medical and Chirurgical, 8.30.
—— Society of Arts, 8. "Canada and its National Highway," by Alexander Begg.
WEDNESDAY, 24th.—Geological, 8.
—— Society of Arts, 8. "Domestic Electric Lighting," by W. H. Preece, F.R.S.
THURSDAY, 25th.—Royal, 4.30.
—— Royal Institution, 3. "Electro-Chemistry," by Prof. Dewar, F.R.S.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "Certain Appliances for the Utilisation of Refuse and Dust Fuels," by Walter G. McMillan.
FRIDAY, 26th.—Quekett Club, 8.
—— Royal Institution, 9. "On Certain Properties common to Fluids and Solid Metals," by Prof. W. Chandler Roberts-Austen, F.R.S.
SATURDAY, 20th.—Royal Institution, 3. "The Astronomical Telescope," by Howard Grubb, F.R.S.
—— Physical, 3. "On an Arc Lamp suitable for the Duboscq Lantern," by Prof. S. P. Thompson.

UNIVERSITY OF MELBOURNE.

CHAIR OF CHEMISTRY.

The Chair of Chemistry in the University of Melbourne being now VACANT, candidates for appointment are requested to send in their written applications, which should contain the names and addresses of their references, or be accompanied by copies of testimonials in triplicate, on or before the 29th instant, addressed to the undersigned. The duties of the Professor will be to teach—(1) Inorganic Chemistry; (2) Organic Chemistry; (3) Metallurgy; (4) Practical Chemistry, with general supervision of the laboratory practice by the students, and generally to perform the customary duties of a professor. The Professor will have the aid of a competent assistant.

The salary will be during the first five years £750 a year with a house, or £100 a year in lieu of a house; at the end of each successive fifth year the professor (if his work be approved by the Council) will be entitled to an additional sum of £150 until his salary amounts to £1200 a year and a house, or house allowance as aforesaid, when it will not be further increased. He will hold his office "quamdiu se bene gesserit."

(Signed) R. MURRAY SMITH.
Agent-General for Victoria.

Victoria Office, 8, Victoria Chambers, Westminster.

FOOD AND DRUGS ACT.

The County of Hants will at the next Easter Sessions appoint a PUBLIC ANALYST for the County for a term of three years.—Analysts desirous of applying for the office must send in their applications stating qualifications, terms as to remuneration, &c., to the Clerk of the Peace, County Hall, Winchester, on or before the 31st inst. The Analyst will only be required to analyse at his private laboratory, to which all samples will be sent free of charge. Payment per analysis. Number of samples not guaranteed.

CHEMICAL MANURE AND SULPHURIC ACID WORKS.

TO BE SOLD by Public Roup, within Dowell's Rooms, 18, George Street, Edinburgh, on Wednesday, 24th March, 1886, at 3 o'clock p.m. (unless previously sold by private bargain).

Chemical Manure and Sulphuric Acid Works, presently carried on by Hume Brothers and Company, Limited, at Bo'ness, Linlithgowshire, these extensive Works, which are in good going order, are well situated, and adapted for carrying on Manure Manufacturing. They lie close by the New Dock at Bo'ness and are connected therewith by railway sidings which run through the Works. Vessels of over 2000 tons burthen can be discharged in the Bo'ness Dock, which is fitted with the newest hydraulic machinery. A large sum has been spent on the fixed Plant at the Works, the greater part of which has been erected within the past three years, and the Mills, Engines, and other Machinery are all of the best description and in first-class order. The Furnaces, Acid Towers, and Acid Chambers are likewise in good order.

A comfortable Dwelling-house for Works-foreman, Laboratory Workshops, and convenient Offices are within the ground.

The whole ground, which extends to about 2 acres, 1 rood, 36 poles, 24 yards, is held upon a long lease, 86 years of which have yet to run. The ground rent is £39 13s. 7d. per annum.

For further particulars apply to Mr. James McGown, Manager, at Bo'ness; or, to Davidson and Syme, W.S., 22, Castle Street Edinburgh, who have the title deeds and articles of roup.

Analytical Laboratory to Let.—Two rooms with benches, gas-supply &c. Balances and library optional. Immediate possession if required. Rent, £30 per annum.—34, Old Broad Street, E.C. Apply to F. R. Johnson.

Chemical Works, established 39 years (in Midlands), making Vitriol, Oxide Iron, Ammonia, Manure, &c., for Sale by Private Contract (principals only).—Address, E.B., care of Mr. W. J. Gallop, Railway Station, Derby.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1374.

ON THE DECOMPOSITION OF POTASSIC CHLORATE BY HEAT.

By E. J. MAUMENÉ.

The Chemical Society, at its meeting on the 5th of November last, received a paper by Mr. Frank L. Teed on the Decomposition of Potassic Chlorate by Heat.

Having been myself occupied with this subject at several different times, I hope that the Society will be good enough to accept some observations which seem to me to be of the highest importance.

My first experiments on this subject go back as far as the years 1845 and 1846. They were published in the *Annales de Chimie et de Physique*, vol. xviii., p. 41 (3rd series).

With the object of finding out very accurately the weight of the residue left by the complete decomposition of the chlorate, I concentrated all my care in establishing two points:—

1st. To maintain the temperature at a sufficiently high point to keep the potassic chloride in complete fusion; I obtained this result in the following manner:—I placed bits of charcoal (gas was not then in use) of a uniform size, that of the little finger, in a very regular manner round the very hard glass retort which I was using. During the whole of the operation I prevented the contact of the charcoal and the glass, and I succeeded a great number of times in obtaining the chloride entirely liquid and perfectly transparent even after solidification. I place at the disposition of the Society some of the retorts which I used.

2nd. To determine if the weight of the glass would remain invariable in spite of my extreme precaution.

As the weight of the residue of chloride should be estimated by difference, it was necessary to be able to depend on the invariability of the glass to less than half a milligramme, a degree of accuracy quite possible in such experiments.

The variability of the glass seemed to me, *à priori*, to be a considerable source of error. The glass, even without touching the charcoal, or rather its ash, is exposed to a red-heat for two or three hours in a current of air and ash in a state of atomic powder, the presence of which is shown by even a rough experiment, such as heating a copper pot of water: this pot, though very bright at first, becomes covered before long with a white deposit, soluble in water, and composed almost entirely of sodic and a little potassic chlorides.

The retorts in which the chlorate is decomposed receive the same substances mixed with watery vapour; they absorb while decomposing, according to a well-known reaction, the principal part, viz., the sodic chloride—

$$SiO_2 + NaCl + HO = SiO_2.NaO + HCl.$$

This action is produced without altering the polish of the glass to an appreciable extent, and increasing the weight of the retorts, in the following manner:—

Tare of the Retorts.

Before.	After.	Increase of weight.
29·810	29·848	0·038
21·108	21·153	0·045
29·812	29·848	0·036
48·069	48·100	0·031
48·138	48·189	0·051
30·1865	30·2285	0·142
36·113	36·152	0·039

The Society sees of what interest this very simple observation was at a time when glass was considered unchangeable under the conditions indicated.

The complete work obtained for me a public recognition from Berzelius, of which I would not speak if it were not necessary to offer to the Chemical Society a guarantee of the value of my experiment (*Compte Rendu Annuel*, 1848, p. 12).

Since this period I have made a fresh study of the subject from another point of view, that of the change to heptachlorate.*

This point of view was forced on me by the general theory of chemical action of which the first conception was presented to the Académie des Sciences on March 6th, 1864, and which, in spite of its advantages, is very little known.

One of the proofs of the correctness of this theory seems to me to be the explanation of the fact, *inexplicable without it*, of the production of the heptachlorate by the decomposition of potassic chlorate.

Below is the proof, as it was published in the *Mondes* of June 13th, 1872, p. 262 (after a short preamble which is necessary to understand the calculation of the decomposition, and which I reproduce):—

Preamble.—All compound bodies submitted to the action of heat ought to be considered at the moment of their decomposition simply as mixtures of the two bodies of which they are formed; for example, a salt formed of an acid and a base is nothing more than a mixture of this acid and this base at the moment when heat brings about the decomposition of this salt. We can calculate, *à priori*, the results of the decomposition by applying the law of mixtures; the following are examples:—

3rd. *Decomposition of Potassic Chlorate.*—Before going any further I must beg the Society to allow me to make a slight deviation. It is now nearly twenty-two years since my "Theory" was published: during this long time I have never ceased accumulating information on analogous examples. I am able to state that I have never up to the present time found *any exception* to the rule which I have just mentioned. *Chemistry in its entirety can be calculated by means of the two laws of the "General Theory."*

We have for the two constituent bodies $ClO_5 = 75{\cdot}5$, $KO = 47$,—

$$\overline{|M|}\, n = \frac{75{\cdot}5}{47}.$$

Strictly speaking the calculation ought to be done with these two numbers, and I ought to write—

$$47ClO_5 + 75{\cdot}5KO = \ldots;$$

but this calculation is sometimes very fatiguing, and, while insisting on the necessity of doing it when very great accuracy is needed, I have simplified the numbers as follows:†—

$$n = \frac{75{\cdot}5}{47} = 1{\cdot}61, \text{ say } \frac{16}{10} = \frac{8}{5}.$$

$$8KO + 5ClO_5 = 2ClO_7,KO + 3KO_4 + 3ClK + 5O \ldots (\delta)$$

There remains $3ClO_5$ *free*.

This consequence of the Theory, this *free* $3ClO_5$, has perhaps influenced the minds of chemists more than anything else in making them reject the Theory itself without further examination.

But what can be more simple? that the two constituents of the salt, ClO_5 and KO, should be entirely separated, and therefore *free*, at the moment of decomposition, is undeniable. That these two bodies, free at a certain temperature, should form other bodies, *stable at the same*

* It would be preferable to call it *chlorogale*, according to the rule which I proposed—"Théorie Générale de l'Action Chimique," 1880, p. 493.

† Mistakes which I was unable to prevent in the *Mondes* oblige me to continue with that which was printed in my "Théorie Générale," p. 110 to 115.

temperature, is also undeniable and easy of comprehension.

The only point which is not so easy to understand is that the two bodies react at equal weights.

But the Chemical Society may find in my General Theory (of which I have the honour of bringing forward an example) a sufficient number of proofs of the accuracy of the calculations based on this fact to grant me its indulgence when I say *these calculations are never wrong.*

Since at equal weights 8KO can only react with $5ClO_5$, the three other molecules of ClO_5 in the retort are free at the moment of decomposition: *they are during a time more or less limited, but always very short,—nothing more than witnesses of the action of the five first molecules with the* 8KO.

Should this fact prevent them from reacting, *a little later*, with the products of the first reaction (which I call the normal reaction)? Evidently not! for example, they react with KO_4, *always following the law of equal weights*, and give ($KO_4=71$):—

$$\boxed{M}\ n = \frac{75{\cdot}5}{71} = 1{\cdot}06, \text{ say } 1{\cdot}00.$$

$$ClO_5 + KO_4 = ClO_7.KO + O \quad \ldots \quad (\gamma)$$

and since we have $3ClO_5$ at the same time as $3KO_4$, we get—

$$3ClO_5 + 3KO_4 = 3ClO_7.KO + 3O \quad \ldots \quad (\gamma)\times 3.$$

No other reaction is possible at this temperature.

Now if we wish to represent the first phase of the decomposition of the chlorate, that which produces the heptachlorate with any destruction of the salt (*the maximum production*), we can do it by simply adding the two equations (δ) and (γ)×3, as follows:—

$$\begin{array}{rrrrr} 8KO + 5ClO_5 & = 2ClO_7.KO & + 3KO_4 + 3ClK & + 5O & (\delta) \\ 3KO_4 + \quad 3ClO_5 & = 3ClO_7.KO & & + 3O & (\gamma)\times 3 \\ \hline 8KO \;.\; ClO_5 & = 5ClO_7.KO & & + 3ClK + 8O & (m). \end{array}$$

I have given sufficient proof of the soundness of this calculation by the direct extraction of ClO_7KO, obtained at a constant temperature in a bath of fusible metal or of solder.

The working out of the equation (*m*) leads us to—

1. Maximum production of heptachlorate.. 70·66
2. Oxygen given off .. .. 6·53

With the greatest care I have not been able to extract more than 68·20 of heptachlorate instead of 70·66; but I must not forget to state that the *simplified* calculation which I have just brought forward gives a figure a little too high, as we shall see directly.

As to the oxygen liberated, not having yet spoken of it I will say nothing now, but will revert to it later on.

I now come to the work of Mr. Teed.

Our colleague has evidently set himself to estimate the two products of which the value can be found with great accuracy.

1st. *Oxygen set free.*—This gas can be estimated by the difference in weight of the retort before and after heating. We need not fear that the glass has changed in weight, as carbon was not used; Mr. Teed used a small lamp (whether gas or oil it matters not).

2nd. *Chloride of Potassium produced.*—This body can be weighed with the greatest accuracy by dissolving in water, as Mr. Teed did, the residue of the decomposition, either partial or complete, of the chlorate, and estimating the chloride by means of a decinormal solution of nitrate of silver (with a chromate as indicator).

By this means Mr. Teed has studied the more or less advanced decompositions of the chlorate, and by comparing the results he has made use of the following terms in the equation for the maximum production of heptachlorate:—

$$10ClO_5.KO = 6ClO_7.KO + 4KCl + 12O \quad \ldots \quad (T).$$

Now the Chemical Society can at once see that the equation is in fact nothing more or less than the one I gave *thirteen years ago.* In fact if we multiply the equation (*m*) by $\frac{4}{3}$ it becomes—

$$10ClO_5.KO = 6{\cdot}25ClO_7.KO + 3{\cdot}75KCl + 10{\cdot}728O \ldots (m)\times\tfrac{4}{3}.$$

No one, I venture to say, can help understanding, even at the first glance, the reasons of the slight differences between the two equations of Teed and Maumené.

These differences come from two causes:—

The first is that Mr. Teed, still imbued with the classical hypothesis,—that is to say, having faith in the most simple coefficients,—has simply written—

6·0000 ClO_7 KO and
4·0000 ClK

without being able to guarantee the absence of all decimals.

The second cause is that M. Maumené, in spite of his recommendation to calculate, *in important cases*, with non-simplified numbers, has given the results simplified *arithmetically*, but slightly incorrect *chemically*, in order to diminish the shock of novelty of his theory.

The true numbers would be—

$$\begin{array}{rrrr} 75{\cdot}5KO + 47ClO_5 & = 18ClO_7.KO + 28{\cdot}5KO_4 + 29KCl + & & \\ & & +52{\cdot}5O & \ldots (\delta') \\ 28{\cdot}5KO_4 + 28{\cdot}5 & = 28{\cdot}5ClO_7.KO & + & \\ & & +28{\cdot}5O & \ldots (\gamma') \\ \hline 75{\cdot}5ClO_5.KO & = 46{\cdot}5ClO_7.KO & +29KCl + & \\ & & +81O & \ldots (m') \end{array}$$

or, dividing by 7·55,—

$$10ClO_5.KO = 6{\cdot}159ClO_7KO + 3{\cdot}841ClK + 10{\cdot}728O,$$

an equation of which the differences with that of Mr. Teed are sufficiently slight to really leave no doubt in the minds of competent people.

1st. Mr. Teed's equation is an approximation very near the truth, but an approximation.

2nd. M. Maumené's equation, dictated by a general theory, is an approximation still nearer the truth, as is proved more and more, as very exact experiments are made, like those of Mr. Teed.

Mr. Teed has observed, as I myself have already done, that the classic equation—

$$2ClO_5.KO = ClO_7.KO + KCl + 4O$$

has no justification. I should be permitted to repeat what I have so often said (*vox clamans in deserto*, or nearly so), —*No classic equation is correct.*

I must here call the attention of the Chemical Society to the method of calculating the second of my equations, viz., (δ').

Many persons would not willingly admit the possibility of $28{\cdot}5KO_4$ by the side of 29KCl: a body very rich in oxygen next to a body which had none, one would be tempted to say—

$$12KO.ClO_7 + 28{\cdot}5KO + 17KCl,$$

but it would be necessary, in order to divide the oxygen in this manner, for KO to be a body which has lost all tendency to peroxidation; and it is not for English chemists to learn the results of Mr. Vernon Harcourt's work (nor even the earlier works of Gay-Lussac and Thenard).

It is therefore necessary to divide the oxygen in such a manner as to form the greatest possible quantity of KO_4, because the existence of this body is not only possible at the temperature of the decomposition of the chlorate, but it is even more stable than the heptachlorate. And now, if the Society will continue to bestow on me this attention, which it may rest assured I will not abuse, I hope to have the honour of bringing before it a fact of the highest importance.

I have used KO_4 in my calculations because the *shock of novelty* of the theory, of which I have just spoken, forces me to use the results of experience, such as KO_4 without any alteration. But any chemist who asks him-

self why the alkaline peroxides are KO_4 for potassium, NaO_2 for sodium, &c., will certainly find no answer in classical chemistry armed with all its resources.

The Chemical Society will certainly not refuse to allow that the General Theory undertakes to reply to such questions, and makes the following answers:—The peroxide of potassium is not KO_4, but KO_5, or more exactly K_8O_{39}, because it is formed at equal weights. The peroxide of sodium is not NaO_2, but NaO_3, or more exactly Na_8O_{23}, because it also is formed at equal weights.

The researches made on these bodies before this theory gave KO_4 according to Vernon Harcourt,

NaO_2 „ „

NaO_3 „ Gay-Lussac and Thenard.

The General Theory leaves me no sort of doubt as to these indications, above all in such simple cases; I have commenced a series of experiments, of which the first results are very nearly K_8O_{39} and Na_8O_{23}. I shall publish them soon. But in the meantime, and in the conviction of having to admit these numbers, I have made the calculation of the decomposition of the chlorate with KO_5 (for simplicity) instead of KO_4. This modification will not sensibly affect the results, and not to fatigue the Society I will not insist on it.

I only ask permission, in closing, to commend to the Society the General Theory, the truth of which becomes more evident every day as the tests to which it is submitted are made with greater accuracy.

Mr. Teed was certainly not guided by it, and still he has just confirmed its indications by a new and perfectly independent proof.

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

(Continued from p. 138.)

Influence of Free Acid and of Acid-Proteid Matter on the Diastatic Action of Saliva.

THE influence of dilute acid solutions on the diastatic action of saliva is naturally a point of considerable physiological importance. In view of the rapid passage of the salivary secretions into the stomach, we need to have accurate knowledge of the exact influence of free acid and acid-reacting fluids on the ferment and its diastatic activity.

In considering this question we do not need now to take into account the older observations of Jacubowitsch, Lehmann, Schiff, Watson, Brücke, Hammarsten, and others, since these led to no agreement of opinion, and more recently acquired knowledge has rendered necessary different methods of procedure.

In 1881 it was announced by one of us† that the ferment of saliva was destroyed on being warmed for two hours with gastric juice containing 0·2 per cent hydrochloric acid; also that the same treatment with 0·2 per cent hydrochloric acid alone caused great destruction of the ferment, so that on neutralisation diastatic action was greatly diminished. At the same time it was pointed out that much smaller percentages of acid, even 0·025 per cent,‡ diminished the diastatic action of the ferment very materially. Shortly after this similar results were obtained independently by Langley,§ who, in an interesting paper on the destruction of ferments in the alimentary canal, pointed out that ptyalin from the parotids of a rabbit was destroyed by digestion with a small amount of gastric juice, and also that weak solutions of the ferment were more or less destroyed by heating at 40° C. with 0·014 per cent hydrochloric acid. In comparing these latter experiments with the preceding, it is to be remembered that the former were made with 25 c.c. of filtered human saliva,—a much stronger solution doubtless, both as regards the ferment and the albuminous matter present.

Later it was pointed out by one of us* that peptones have a very decided influence on the diastatic action of saliva in acid solutions; that while the presence of 0·025 per cent hydrochloric acid prevented the conversion of but 3·50 per cent of the starch into sugar, the presence of 1 per cent peptone allowed the conversion of 48·85 per cent of the starch, 7 per cent more than the saliva alone would convert under like conditions,—a fact which would indicate something more, on the part of the proteid matter, than a mere union of the peptone and acid. Undoubtedly there was a combination of the peptone and acid, but in addition there was manifested the direct stimulating action of the proteid matter. At the time these experiments were made, however, we were unaware of Danilewski's† method of testing for free acid with tropæolin oo, by which he proved the union of acids with various forms of proteid matter; compounds acid to test-papers, but not containing free acid. Falk‡ likewise noticed the influence of peptones on diastatic action, in an acid solution of malt infusion; thus by adding a small amount of 0·0135 per cent hydrochloric acid to an infusion of malt, and this to some starch paste, no reaction for sugar could be obtained; but by adding the same proportion of acid and some peptone, then the sugar reaction soon appeared. This fact Falk considered as evidence of the union of the acid and peptone.

In view of these results we have repeated some of our previous work, under different conditions, trying many additional experiments, especially as in a recent paper on the amylolytic action of saliva, Langley and Eves§ have arrived at some conclusions not in accord with our results.

a. Influence of Acid-Proteid Matter.

We have used the tropæolin test for the detection of free acid, whenever it has been necessary in our work, employing the method as recommended by Danilewsky. The tropæolin oo was dissolved in methyl alcohol (saturated solution), and, when a test for free acid was to be made, drops of the alcoholic solution were allowed to evaporate on a porcelain plate at 40° C., and then, while still at 40° C., a drop of the fluid to be tested was added and allowed to dry. Free hydrochloric acid causes the dry residue to take on a violet colour. We have made a number of trials to ascertain how small a percentage of free hydrochloric acid can be detected by this test. Using a standard solution of hydrochloric acid of known strength,‖ we have found that 0·003 per cent of this acid can be detected with certainty, a drop of such a mixture giving a distinctly recognisable violet colour. A smaller percentage cannot be recognised, and we have therefore invariably deducted the above amount in our various tests for free acid.

The amount of proteid matter naturally present in saliva, and which is capable of combining with acids, is apparently quite constant. Langley and Eves found, as a mean of several observations, that 5 c.c. of filtered neutralised saliva contained proteids capable of combining with 2 c.c. of 0·1 per cent hydrochloric acid. We have found, as a mean of eight determinations, that 20 c.c. of filtered neutralised saliva contained proteids capable of combining with 7·74 c.c. 0·1 per cent hydrochloric acid. In an attempt to ascertain approximately how much

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.
† Chittenden and Griswold, *Amer. Chem. Jour.*, vol. iii., 305.
‡ Irrespective of the proteid matter.
§ *Journal of Physiology*, vol. iii., No. 3.

* Chittenden and Ely, *Amer. Chem. Jour.*, vol. iv., 114.
† *Centralbl. Med. Wiss.*, 1880.
‡ *Virchow's Archiv*, lxxxiv., 1881, p. 130.
§ *Loc. cit.*
‖ All of our standard acid solutions were of exactly the strength specified, as was proved by titration with standard solution of silver nitrate.

proteid matter this amount of acid signified, we took the results of our experiments with peptones, in which we found that one grm. of pure neutral peptone required 48·0 c.c. 0·1 per cent hydrochloric acid to saturate it. Consequently 1 c.c. of 0·1 per cent acid would combine with 0·0208 grm. peptone, and, assuming that the combining power of the proteids present in saliva is the same as that of peptones, the 20 c.c. of saliva would contain 0·16099 grm. proteid matter, equal to 0·804 per cent,—a result which at once shows that the combining power of the proteids of saliva and peptone must be quite different, or, as is more probable, that considerable of the acid added is used up in reacting with the phosphates of the alkalies present in the saliva.

Saliva, as a rule, does not contain much more than 0·5 per cent solid matter, and Hammerbacher has found in human mixed saliva 0·139 per cent albumen and ptyalin.*

A comparison of the diastatic action of neutral saliva considerably diluted, and similarly diluted saliva in which the proteids present have been saturated with acid, shows at once that acid-proteid matter, even though present in but small quantity, has a distinctly stimulating action on the salivary ferment.

The following experiments will illustrate this point, and also show the extent of the stimulation:—

SERIES XIV.

A. 40 c.c. filtered saliva were neutralised and then diluted to 200 c.c.

B. 40 c.c. of the above diluted saliva required 6·8 c.c. 0·05 per cent HCl to saturate the proteids present = 0·0074 per cent combined HCl.

Two digestions each were made with A and B, using quantities of the above salivas equivalent to 4 and 2 c.c. of the original saliva.

		Wt. Cu in one-eighth.	Total amount sugar formed.
20·0 c.c.	A ..	0·0913 grm.	0·3720 grm.
23·4	B ..	0·0987	0·4016
10·0	A ..	0·0850	0·3472
11·7	B ..	0·0940	0·3832

		Starch converted.
20·0 c.c.	A	33·49 per cent.
23·4	B	36·15
Increase		2·66
10·0 c.c.	A	31·26 per cent.
11·7	B	34·49
Increase		3·23

It is seen that the addition of the acid in this instance causes a very decided increase in the diastatic activity of the saliva. The amount of combined acid present in the 100 c.c. of digestive mixture in the two cases was 0·0017 and 0·0008 per cent respectively, yet the presence of this small amount of combined acid manifestly acts as a stimulant to the diastatic ferment.† Even still smaller percentages of acid-proteid matter have an equally decided action on the salivary ptyalin.

The following series of experiments illustrate this point, and at the same time are confirmatory of the preceding one:—

SERIES XV.

A. 40 c.c. filtered saliva were neutralised and diluted to 200 c.c.

B. 50 c.c. of the above diluted saliva required 4·75 c.c. 0·05 per cent HCl to saturate the proteids. The solution was distinctly acid to litmus-paper, and contained 0·0043 per cent combined HCl.

Four digestions were made with both A and B, using quantities of saliva in each case equivalent to 4, 2, 1, and 0·5 c.c. of the original saliva.

		Wt. Cu in one-eighth.	Total amount sugar formed.
20·0 c.c.	A ..	0·0925 grm.	0·3768 grm.
21·9	B ..	0·0959	0·3912
10·0	A ..	0·0827	0·3368
10·95	B ..	0·0876	0·3576
5·0	A ..	0·0671	0·2744
5·5	B ..	0·0751	0·3064
2·5	A ..	0·0305	0·1296
2·75	B ..	0·0375	0·1568

		Starch converted.
20·0 c.c.	A	33·85 per cent.
21·9	B	35·22
Increase		1·37
10·0 c.c.	A	30·32 per cent.
10·95	B	32·19
Increase		1·87
5·0 c.c.	A	24·69 per cent.
5·5	B	27·58
Increase		2·89
2·5 c.c.	A	11·68 per cent.
2·75	B	14·10
Increase		2·42

Here the same results are to be seen as in the preceding experiment, although the amount of proteid matter is much less. In both series of experiments it is to be noticed that as the percentage of combined acid is diminished, the difference between the diastatic activity of the neutral solution and the corresponding acid solution is increased; at the same time it is to be seen that in the first series of experiments, where the percentage of proteid matter is larger, there is a greater increase in the conversion of starch with the 23·4 c.c. of acid-reacting saliva than with the 21·9 c.c. of the acid-reacting fluid of the second series of experiments, with its smaller percentage of proteid matter.

(To be continued).

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 140.)

ON POTASH.

THE Committee on Potash made the following report:—

Methods of Estimating Potash.

The first meeting of Agricultural Chemists, held in Washington July 28, 1880, recommended the following method of estimating potash:—

Solution in water, removal of sulphates, phosphates, and magnesia by barium hydrate, clearing with oxalate or carbonate of ammonia, and precipitating with platinum chloride.

This method has at least the merit of brevity.

At the meeting of the same Association in Cincinnati, August, 1881, no action was taken with reference to potash.

At the Atlanta convention, May, 1884, Dr. MEMMINGER described a method of determining potash, given below:—

* *Jahresbericht für Thierchemie*, 1881, 269.

† Doubtless these percentages of combined acid are too high, since, as before mentioned, some of the acid added probably reacts with the phosphates naturally present in the saliva.

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

Two to 2·50 grms. of the fertiliser are weighed from a weighing tube into a beaker (capacity about 400 c.c.). In the case of ammoniated fertilisers, the fertiliser is first subjected to carbonisation at a low temperature, when cotton seed or the like is present. To the material is added 5 c.c. of strong hydrochloric acid and then a little water. Heat is applied, and when the mass is at the temperature of 212° F., boiling water is added until the entire bulk will come to about 200 c.c.; to this is added a slight excess of barium chloride, and after a few minutes' boiling a strong ammonia is added until the mass is entirely alkaline. To this is then added first a slight (very slight) amount of milk of lime, then carbonate of ammonia in excess, and then a slight excess of oxalate of ammonia. The entire contents of the beaker are then brought to the boiling point and there kept for two or three minutes. After the mass has had time to precipitate the fluid is decanted, and after two decantations with boiling water (using 200 c.c. each time) the entire mass is thrown on a filter and washed three or four times with boiling water.

The filtrate is now evaporated in a porcelain dish over the direct flame of a Bunsen burner, and after the evaporation is carried to near the crystallising point of the salts present a little strong ammonia is added and then a few c.c. of oxalate of ammonia. The precipitate which now forms is thrown on a filter and the filtrate caught in a large crucible. After a sufficiency of washing the filtrate is evaporated very carefully until perfectly dry, and then the ammonium salts gotten rid of by ignition over a Bunsen burner. The carbonised mass contained in the crucible is moistened with 1 c.c. of very dilute hydrochloric acid (1 c.c. strong HCl to 4 c.c. of H_2O) dissolved in a little boiling water, and filtered into a weighing crucible (porcelain). The mass is washed until there is no reaction with either litmus-paper or silver nitrate, the contents of the crucible carefully evaporated until no more than about 2·5 c.c. remain in the crucible, and to this is added about 10 c.c. of 95 per cent alcohol, and 5 c.c. of standard bichloride of platinum solution. The precipitate then formed of bichloride of platinum and of potassium is allowed to stand over-night, and in the morning, after the crucible has been jarred to make the precipitate fall to the bottom, the supernatant liquid containing an excess of platinum solution is either poured off or else sucked up by means of a very fine pipette. (I have found this better and easier than decantation.) After three or four washings with alcohol (95 per cent), using about 10 c.c. each time, the same process is employed for removing it, allowing time for each subsidence of the precipitate. The crucible is now placed in a steam bath, and the temperature kept at about 230° F., until the weight of the precipitate is constant. Of course the weight of the crucible subtracted from the weight of the crucible plus the precipitate dried at 230° F., gives the weight of the bichloride of platinum and potassium. In the case of kainite salts I employ the same plan of procedure, using, however, in the precipitations much less of ammonia and carbonate of ammonia, and seldom using oxalate. The original 2 or 3 grms., however, which is contained in my final filtrate after ammonium salts are gotten rid of, is, of course, brought to a definite bulk, and then an aliquot portion taken, so that I shall not have to use too great a quantity of bichloride of platinum.

Professor NOYES suggested the following improvements on the above plan:—

I precipitate with platinum chloride in a small weighed beaker, evaporate, take up with alcohol, wash by decantation, pouring off through a small filter, then extract the filter with hot water, washing into the beaker containing the main precipitate, evaporate to dryness, and weigh. During this last evaporation it is advisable to add a drop or two of aqua regia to avoid reduction to metallic platinum.

Professor STUBBS said, speaking of the above method:—
I use for washing potassic platinic chloride alcohol of 95 per cent purity mixed with one-sixth of its bulk of ether.

Dr. WILEY gave his experience in the use of the Gooch crucible in potash determinations:—

Mr. President, I have heard a great deal of discussion to day about estimating potash on a weighed filter. Now, sir, I think the use of paper filters in such estimation is a relic of barbarism. The perforated platinum of crucible, with its blanket of asbestus pulp, is to chemistry what the breech-loader and needle-gun are to war. The day of flint-lock muzzle-loading muskets and of weighed paper filters has passed. The Gooch filter is the great labour-saving machine of chemical industry. In potash determinations the double salt can be first dried and weighed. Then the salt is decomposed by ignition in a stream of hydrogen, the potassium chloride washed out, and the crucible dried and re-weighed. Thus an easy and reliable check is placed on every determination.

At the same Convention the Committee on Potash, consisting of Drs. E. H. JENKINS, W. J. GASCOYNE, and H. W. WILEY, made the following recommendation:—

That for the present nothing better could be suggested for the determination of potash than the plan adopted by the Washington convention.

The report was adopted.

At the Philadelphia meeting, September 1884, the above Committee on Potash reported the following method, which was adopted:—

Boil 10 grms. of the fertiliser with 5 c.c. of strong hydrochloric acid and 300 to 400 c.c. of water for 10 minutes. Cool the solution, and, without filtering, make it up to 1000 c.c.; mix thoroughly and filter through a dry filter.

Take an aliquot corresponding to 0·5 or 1 grm.; dilute, if necessary, to about 150 c.c.; heat to boiling, and precipitate the sulphuric acid with a slight excess of barium chloride solution. Without filtering add an excess of barium hydroxide, and heat again to boiling. Filter and wash, at first by decantation, till the washings are free from chlorides. Heat the filtrate nearly to boiling and precipitate the barium salts with ammonium carbonate and a little ammonia solution. Filter and wash, evaporate filtrate and washings to dryness, and ignite *below a red heat* till the ammonium salts are removed and the organic matter is oxidised as completely as possible. The residue, consisting of chlorides of potassium and sodium, with some charcoal and possibly a little barium salt, which escaped precipitation, is digested with hot water, a few drops of ammonium carbonate are added, and the solution filtered and washed. The filtrate and washing are again evaporated to dryness, and ignited gently.

The mixed chlorides are dissolved in water, an amount of platinum tetrachloride solution is added more than sufficient to form the double salt with all the potash and *soda* present, and the solution is evaporated at or below 100° C., so nearly to dryness that it becomes solid on cooling. To the cold mass 10 to 20 c.c. of strong alcohol (80 to 95 per cent) are added, and the mass is well broken up with a stirring rod or pestle. After standing 5 to 10 minutes the supernatant liquid, which must have a reddish colour from excess of platinum tetrachloride, is poured on a filter, more alcohol is added to the mixture of the double salts, and the whole stirred and pulverised and washed by decantation until the washings are perfectly colourless.

The precipitate is then brought on the filter by means of a wash-bottle containing alcohol. The salt is dried at 100° C. and weighed. After weighing, the salt is dissolved from the filter with hot water, and the filter is dried and weighed together with any platinum which may have been reduced in drying down the solution with platinum tetrachloride or other impurities.

The actual potash is reckoned from the weight of the double chloride of potassium and platinum by multiplying by 0·19308.

Potassium chloride is reckoned from the double salt by

multiplying by 0·3056. These factors are based on the following atomic weights:—

Platinum	197·18
Potassium	39·13
Chlorine	35·46
Oxygen	16·00

At the same meeting a committee was appointed, consisting of H. W. Wiley, W. J. Gascoyne, and Clifford Richardson, to examine anew the subject of potash determination and report at the annual meeting of the Society at Washington, September, 1885.

Glancing at the method used for estimating potash in fertilisers in other countries, the following points are brought to view:—

The method in use in Germany twenty years ago for estimating potash in crude kainite is given by Stohmann.*

(1.) Precipitation of sulphuric acid with barium chloride, separation of the magnesia by barium hydrate, precipitation of calcium and excess of added barium by ammonium carbonate, evaporation, and ignition, and final estimation of potash by platinic chloride.

(2.) The liquid after treatment with barium chloride is evaporated to dryness with oxalic acid, the residue ignited, the chlorides dissolved in water, the magnesia filtered off, and the potash estimated with platinic chloride.

To avoid the repeated filtration the following method was employed:—

(3.) About 10 grms. of the finely-powdered salt are treated with 300 c.c. hot water brought to a full boil and without minding the insoluble portion treated drop by drop with barium chloride. The barium sulphate settles rapidly, and, therefore, with care almost all excess of barium can be avoided. The whole, after cooling, is made up to 100 c.c., the volume of the precipitate having little influence on the result.

It is now filtered, and 100 c.c. of the filtrate corresponding to 1 grm. of the salt mixed with a solution of platinic chloride, which contains at least 2 grms. of platinum. This is now evaporated to dryness on the water-bath, treated with 80 per cent alcohol, rubbed up with a glass stirring rod, and washed by decantation until colourless. The whole is then brought on to a weighed filter, dried at 100°, and weighed.

(To be continued.)

THIRD REPORT OF THE COMMITTEE†

RE-APPOINTED FOR THE PURPOSE OF DRAWING UP A STATEMENT OF THE

VARIETIES OF CHEMICAL NAMES WHICH HAVE COME INTO USE,

FOR INDICATING THE CAUSES WHICH HAVE LED TO THEIR ADOPTION, AND FOR CONSIDERING WHAT CAN BE DONE TO BRING ABOUT SOME CONVERGENCE OF THE VIEWS ON CHEMICAL NOMENCLATURE OBTAINING AMONG ENGLISH AND FOREIGN CHEMISTS.‡

(Concluded from p. 141).

XIV.

1. —
2. —
3. —
4. —
5. Sulphoantimoniate.
6. —
7. Sulphostibias natricus ($Na\ Sb_2$).
8. —
9. —
10. Fünffachschwefelantimonnatrium.
11. Antimon persulphid-Natrium (Sulphostibias natricus cum aqua) (Sb_2S_5,NaS+12Aq).
12. Natrium antimon Sulphid ($3NaS+SbS_5$).
13. Antimon-persulphid-Natrium. Antimonpersulphidschwefelnatrium, &c., &c. (Sb_2S_5.NaS).
14. —
15. —
16. Sulphantimoniate ($3NaS.SbS_5$).
17. Sulfantimoniate de sulfure de Sodium ($3NaS.Sb_2S_5$).
18. —
19. Natrium sulphantimoniat ($3NaS,SbS_5$).
20. Sulphantimoniate of sodium ($3NaS,SbS_5$).
21. Sulfantimoniate de sulfure de sodium ($3NaS.Sb_2S_5$).
22. —
23. Sulphantimonate of sodium (Na_3SbS_4 or $3Na_2S.Sb_2S_5$).
24. —
25. —
26. Sulphantimoniates (Sb_2S_5,$3M_2S$ or SbS_4M_3).
27. Sodic sulphantimoniate (SbS_4Na_3).
28. Sulfo-antimoniate de sodium (SbS_4Na_3).
29. Sulphantimoniate.
30. Natriumthioantimonat (Na_3SbS_4).
31. SbS_4Na_3, or $(SbS)S_3Na_3$.
32. Sodium sulphantimonate.
33. Trisodic sulphantimoniate (Na_3SbS_4).
34. Sodium thioantimonate (Na_3SbS_4).
35. Trisulphosodic sulphantimonate ($SbS''Nas_3$)
36. —

XV.

1. Fluat of potass and silica.
2. Fluate of potash and silica.
3. Fluosilicate of potash.
4. Silico-fluate.
5. Fluosilicate of potash.
6. Silicofluoride of potassium ($po+2Si+3f$).
7. —
8. Silicofluoride of potassium ($po+2Si+3f$).
9. Double fluoride of silicon and potassium ($2SiF_3.3KF$).
10. Fluor-siliciumkalium (KF,SiF_2).
11. Fluorsiliciumkalium. Kieselfluorkalium ($3KF_2,2SiF_6$).
12. Fluorkiesel Kalium.
13. Kalium Kieselfluorid ($3KF,2SiF_3$).
14. —
15. Fluosilicate of potassium, silicofluoride of potassium (SiF_2+KF).
16. Double fluoride of silicon and potassium ($2SiF_3,3KF$).
17. Hydrofluosilicate de potasse ($3KFl,2SiFl_3$).
18. Double Fluoride of Silicium and potassium ($3KF,SiF_3$).
19. Kieselfluorkalium, Fluorkieselkalium ($3KaFl,2SiFl_3$, oder $KaFl,SiFl_2$).
20. Silicofluoride of potassium (KF,SiF_2).
21. Hydrofluosilicate de potasse ($3KFl,2SiFl_3$).
22. —
23. Silicofluoride of potassium. Potassic Silicofluoride ($2KF,SiF_4$).
24. Fluorure double de silicium et de potassium.
25. Kieselfluorkalium.
26. Double fluoride of silicium and potassium ($2KF,SiF_4$).
27. Potassic fluosilicate (K_2SiF_6).
28. Fluosilicate de potassium.
29. Silicofluoride of potassium ($2KF,SiF_4$),
30. Metallsilicofluorüre.
31. Kieselfluormetalle (SiF_4,MF_2).
32. Double fluoride of silicium and potassium ($2KF,SiF_4$).
33. Potassic silicofluoride.

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* *Zeit. Anal. Chem.*, vol. 5, pp. 106 *et seq.*

† Consisting of Professors Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary), and V. H. Veley.

‡ Read at the British Association, Aberdeen Meeting, Section D.

34. Silicofluoride, potassium fluosilicate (K_2SiF_6).
35. Potassic silicofluoride ($SiF_6K_2 = SiF_4, 2KF$).
36. Potassium fluosilicate.

XVI.

1. Muriat of platinum and potass.
2. Muriate of platinum and potash.
3. —
4. —
5. Bichloroplatinate of potassium.
6. Platino-bichloride of potassium (pl+2c)+(po+c).
7. —
8. Platino-bichloride of potassium (pl+2c)+(po+c).
9. Chloride of platinum and potassium ($KCl+PtCl_2$).
10. Zweifach Chlorplatinkalium ($KCl+PtCl_2$).
11. Kaliumplatinchlorid (KCl_2+PtCl_4).
12. Kaliumplatinchlorid.
13. Kalium-platinchlorid ($KCl+PtCl_2$).
14. Platinchlorid chlorkalium.
15. Double salt of bichloride of platinum with chloride of potassium ($KCl+PtCl_2$).
16. Chloroplatinate of potassium ($KCl,PtCl_2$).
17. Chlorure double de platine et de potassium ($PtCl_2+KCl$).
18. Bichloride of platinum and chloride of potassium ($PtCl_2,KCl$).
19. Kalium-platinchlorid. Kalium chloroplatinat ($KaCl,PtCl_2$).
20. Double chloride of platinum and potassium ($KCl,PtCl_2$).
21. Chlorure double de platine et de potassium ($PtCl_2+KCl$).
22. —
23. Chloroplatinate of potassium, 1866. Potassium platinochloride (K_2PtCl_6). Supp. I., 1872.
24. Chlorure double de platine et de potassium.
25. Kaliumplatinchlorid.
26. Potassium platinochloride ($2KCl,PtCl_4$).
27. —
28. Chloroplatinate de potassium.
29. Platinochloride of potassium ($2KCl,PtCl_4$).
30. Kaliumplatinchlorid.
31. Kaliumplatinchlorid ($2KCl,PtCl_4$).
32. Potassium platinochloride or chloroplatinate ($2KCl,PtCl_4$).
33. Potassic Platinic Chloride.
34. Potassium platinichloride or chloroplatinate (K_2PtCl_6).
35. Potassic Platinic Chloride ($PtCl_4,2KCl$).
36. Potassium chlorplatinate.

XVII.

1. —
2. —
3. —
4. —
5. —
6. Cyanuret of platinum and potassium.
7. —
8. Cyanuret of platinum and potassium.
9. Platino-cyanide of potassium ($K,PtCy_2+3HO$).
10. Einfach-cyanplatinkalium ($KCy,PtCy$).
11. —
12. Kalium Platincyanür ($KCy,+PtCy+3H$).
13. Kalium Platincyanür ($KCy+PtCy+3HO$).
14. —
15. Platinocyanide of potassium ($PtCy+KCy$ or $K,Cpty$).
16. Platinocyanides ($MCy,PtCy$).
17. Cyanure double de platine et de potassium ($KCy+PtCy+3HO$).
18. —
19. Kaliumplatincyanür ($KaCy,PtCy+3HO$).
20. —
21. Cyanure double de platine et de potassium ($KCy+PtCy+3HO$).
22. —
23. Platinocyanide of potassium ($K_2PtCy_4 = 2KCy,PtCy_2$), 1866. Potassio Platinous Cyanide (K_2PtCy_4). Supp. I., 1872.
24. —
25. —
26. —
27. —
28. Platinocyanure de potassium, ($PtCy^4$) K^2+3H^2O.
29. —
30. Kaliumplatincyanür.
31. Kaliumplatincyanür ($2KCy,PtCy_2$).
32. —
33. —
34. Potassium platinocyanide, $K_2Pt(CN)_4+12H_2O$.
35. —
36. Potassium platinous Cyanide.

XVIII.

1. —
2. —
3. —
4. —
5. —
6. —
7. —
8. —
9. Acetate and arsenite of copper, $CuO,(C_4H_3O_3)+3(CuO.AsO_3)$.
10. Essigarsenigsaures Kupferoxyd, $3(CuO,AsO_3)+C_4H_3CuO_4$.
11. Essigsaures Kupferoxid und Arsenigsaures Kupferoxid, $A,CuO+3(AsO_3,CuO)$.
12. Arsenichtsaures und essigsaures Kupferoxyd, $(C\dot{u}A+3C\dot{u}^2\ddot{A}s)$.
13. Arsenigessigsaures Kupferoxyd.
14. —
15. Compound of acetate of copper and arsenite of copper, $CuO.A+3(HO.2CuO+AsO_3)$.
16. Acetate and arsenite of copper, $CuO,(C_4H_3O_3)+3(CuO.As_2O_3)$.
17. Une combinaison, $CuO.C_4H_3O_3+3(2CuO.AsO_3)$.
18. —
19. Eine Verbindung, $CuO,AcO_3+3(2CuO,AsO_3)$.
20. $CuO,C_4H_3O_3+3(CuO,AsO_3)$.
21. $CuO,C_4H_3O_3+3(2CuO,AsO_3)$.
22. —
23. Aceto-arsenite of copper $(C_2H_3O_2)_2Cu'',3(AsO_2)_2Cu'$ or $C_4H_6O_3.Cu''O+3(As_2O_3.Cu''O)$.
24. —
25. —
26. —
27. Cupric acetoarsenite, $Cu(AsO_2)(C_2H_3O_2)$.
28. Un acétoarsénite.
29. —
30. Arsenigessigsaures Kupfer $Cu_2(OAsO)_3(OC_2H_3O)$.
31. —
32. —
33. Cupric Arsenite and Acetate, $3CuAs_2O_4.Cu(C_2H_3O_2)_2$.
34. Copper Acetoarsenite, $3CuAs_2O_4+Cu(C_2H_3O_2)_2$.
35. —
36. Double compound.

Brooke, Simpson, and Spiller, Limited. — The letters of allotment and regret were posted on Saturday. The amount of shares applied for was nearly three times in excess of those offered.

On the Risk of Fire from Nitric Acid.—G. Lechartier.—The author points out that if nitric acid, of the sp. gr. 1.50 or upwards, comes in contact with straw, *e.g.*, by the fracture of a carboy, the heat liberated is, under many circumstances, sufficient to set up spontaneous ignition.—*Comptes Rendus.*

THE CHEMICAL LABORATORIES AT UNIVERSITY COLLEGE, LIVERPOOL.

THE new Chemical Laboratories in connection with University College, Liverpool, which were opened on the 22nd inst. by the Earl of Derby, mark a new and important step in advance, being the first instalment of building undertaken by the College on a scale of academical completeness. A chair of chemistry was included in the original scheme of the College, promulgated in 1878, and endowment for the same was eventually provided by the munificence of Mrs. Grant, of Rock Ferry, who contributed a sum of £10,000 for this express purpose. Dr. Campbell Brown, who for nearly fifteen years had held the position of Lecturer in Chemistry to the Medical School, was elected Professor shortly after the opening of the College in January, 1882, and both before and since that time has, among many other services to the College, spent unwearied pains on providing suitable equipment for the important department committed to his charge.

The entire block is designed for the various branches of chemical study. The work was entrusted to Mr. Alfred Waterhouse, R.A., whose previous experience in the erection of similar laboratories for the Owens College, the Yorkshire College, and the Central Technical Training College at South Kensington, have given him unrivalled mastery among English architects of this particular branch of building. The plans of all the most important Continental laboratories, as well as of those in Great Britain, were carefully studied in designing the plans, and all the latest improvements in ventilation, fittings, and internal arrangements have been carefully compared, and, where practicable, embodied or adapted.

The buildings occupy the western confines of the College site, and are placed in immediate and convenient connection with the Medical School block. The west front contains the principal entrance, which is surmounted by the water-tower, while the eastern elevation looks out upon the College grounds. The most characteristic feature in the building is the large pentagonal apse, which looks southwards, and forms the containing wall of the large lecture and practical theatres, which have been designed expressly with a view to lecturing requirements.

The polygonal angles are relieved with buttresses running up the entire height of the building, and terminating in ornamental head-pieces in terra-cotta. The lower theatre is lighted with dual windows introduced in each of the five polygonal facets, while corresponding ornamental arcading is introduced in the exterior facets of the upper theatre, which (to facilitate artificial darkening) is in part lighted from the roof. This outer polygonal apse is flat-roofed, backed by the gable roof that is carried the full length from side to side of the interior portion of the theatre.

The main front is enriched by the entrance porch and tower, which intervene between the large lecturing theatre annexe and the body of the building, which contains the various supplementary laboratories, museums, and class-rooms, while the tower itself is occupied by the main staircase and minor rooms. The central portion of the building is designed in three gables facing the street, and is built in three storeys. Near one end of this rises the bold and lofty chimney, rendered necessary by the elaborate furnace and ventilation arrangements, which will be described later.

The entire design will be eventually completed by the erection of two large laboratories for qualitative and quantitative analysis placed side by side.

The practical theatre is specially arranged for a large class of students to follow by actual experiment on their own part the demonstrations given by the lecturer, whose table is placed in the middle of the room a few feet away from the back wall and between the entrances. The students' working benches are fifty-two in number, and are arranged in six concentric rows rising one above the other. These rows form segments of circles described from the lecturer's position as a centre. It is hoped that by this arrangement the acquisition of a knowledge of elementary practical chemistry will be greatly facilitated and rendered more thorough. The containing wall of the room opposite the lecturer is itself polygonal. The practical theatre measures 48 feet 6 inches in width and 42 feet 6 inches from the wall behind the lecturer to the centre of the opposite wall. The height of the room is 19 feet 6 inches. There are lofty windows in the polygonal walls and also at both sides of the room. The working benches for students are arranged in pairs, each pair having a small fume chamber and porcelain sink in common, but provided with separate cupboards, drains, gas nozzles, &c. Each student has 4 feet of bench length, the dual bench being about 8 feet long. The lecture table is 20 feet long and 3 feet wide, fitted with every necessary appliance, and on the wall behind are blackboards, fume chambers, cupboards, and shelving. Large fume chambers are also provided for the students' use in addition to the small ones provided in their benches.

Close to the preparation room and practical theatre is the sulphuretted hydrogen room, twenty feet six inches by fourteen feet, with special ventilation and niches for the supply of that malodorous gas for students' use. The remainder of this lower floor of the building is occupied by two rooms for storage, each twenty-two feet by sixteen feet three inches, a lavatory of the same size, retiring rooms for students, heating apparatus, fan chamber, and coal cellar. It may here be stated that the building generally is supplied with warmed fresh air, heated by hot water in large channels below the ground floor, and rising through vertical flues in the thickness of the walls to the various rooms. The fresh air is cleansed by passing through a sheet of water as it enters the building, and its entrance is accelerated by a fan driven by a gas-engine, and also by the method adopted for the extraction of foul air. The chemical fumes from the various fume chambers and other appliances, as well as the naturally vitiated air of the rooms, are drawn downwards through special extraction flues to the base of the upcast ventilating shaft, whose draught is accelerated by the spare heat from the adjacent smoke flue, aided when desired by an open furnace, which can be lit at the base of the shaft. Hot water for drawing off at various points in the building is provided by a separate service, and steam is also laid on for heating students' air ovens, for evaporation and distillation, and to such places as are likely to require its use in experiments. The heating apparatus is arranged to give a temperature of 60° when the external temperature is 25°.

Ascending the principal staircase to the second floor we find the corridors arranged as on the basement, the two southern ones leading to either side of the lecture theatre, and including between them the area and a preparation room for the service of the lecture theatre. The lecture theatre is forty-two feet six inches long and forty-eight feet six inches broad. It has three lofty windows at each side and two sky-lights at the back part of the room, while at night it is lighted by three Bower gas lights; the lecturer has the power of darkening it in the daytime for any special purpose by screens of opaque blinds running in grooves. The seats are arranged in concentric segments of circles having the lecturer's position as their centre, so that every one directly faces the lecturer. It is intended to seat 212 students with sufficient room to use the book-boards for writing and taking notes of the lectures; but 260 can be seated in the ordinary way. The lecture table is twenty-five feet long by three feet wide, and is provided with gas, steam, hot and cold water, with oxygen, hydrogen, and sulphuretted hydrogen supplies; separate taps on the table communicate with an air blast and a vacuum, while wires bring a current of electricity when required. Two flues opening on the table convey fumes and offensive gases to the main upcast shaft.

The table is also provided with a pneumatic trough, a mercury trough, and other conveniences. Behind the table are cupboards for reagents, blackboards, and diagram racks. Overhead is a cove in the ceiling for the purpose of deflecting outwards to the audience the sound of the lecturer's voice. In the wall behind the lecture table is a large fume-chamber, whose glass doors open to the lecture room in front and to the preparation room behind, a powerful draught on each side communicates with the main ventilation shaft. The base of this fume-chamber is a granite table, which is set on rails and can on occasion be moved forward to the lecture table or backward into the preparation room, which also communicates directly with the theatre by a door in the rear of the lecture table.

An ante-room for lecturers, and a large room for apparatus and diagrams, adjoin the lecture theatre. The north corridor of this floor communicates with a private laboratory for a few of the most advanced students, with the professor's room adjoining; a small class-room twenty-two feet by sixteeen feet three inches; and on the other side a chemical museum twenty-eight feet by twenty-four feet.

A staircase leads to two small rooms in the tower and the large water cistern; and also gives access to a lead flat, and a range of storage rooms in the roof. A lift travels from the basement to this storage floor. If we descend the principal staircase to the first floor landing we reach a corridor corresponding to that on the other floors. At the far end of this corridor is the east entrance from the college grounds. South of the corridor are rooms for gas analysis, a room arranged for operations in sealed tubes and other special operations in organic chemistry, a dark room for photography, photometry, &c., and a ladies' cloak room and lavatory. The corridor running north leads on the east to the organic laboratory (twenty-eight feet six inches by twenty-four feet), which will be used temporarily as a quantitative laboratory. The walls are of cream and dark gold-coloured glazed bricks, and the room is supplied with hot and cold water, steam, hot air baths, fume chambers, evaporating niches, and chambers for organic combustions and other conveniences. West of the corridor are three rooms, each twenty-two feet by sixteen feet three, viz., a room for water analysis and distillations requiring steam; a balance room also used as a reading and writing room—to which it is hoped friends will contribute books of reference—and a gas furnace room intended ultimately to communicate with the future large quantitative laboratory. Arches at the end of the north corridor are bricked up at present; but will ultimately lead to the large quantitative and qualitative laboratories, each sixty feet by thirty feet.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

March 13th, 1886.

Prof. BALFOUR STEWART, President, in the Chair.

THE following were elected Members of the Society:—Prof. U. S. Pickering and Mr. A. C. Hayward.

The following communications were read:—

"*On the Growth of Filiform Silver.*" By Dr. J. H. GLADSTONE.

It has long been known that if a piece of metallic copper be placed in a solution of nitrate of silver, replacement of one metal by the other will take place, the silver being deposited in the crystalline form, sometimes having a resemblance to fern leaves, or as superposed hexagonal lates, or knobs. It was observed, however, as far back as 1872, by the late Mr. Tribe and the author, that if nitrate of silver were decomposed by suboxide of copper, instead of the metal, the silver presented itself in threads, which rarely, if ever, bifurcate, but frequently turn at sharp angles or twist in every direction. This was described in the British Association Report for 1872, and it was observed that the same forms occurred in native silver. More recent observations have shown that the particular character and rapidity of formation of these threads depend very much upon the strength of the solution and the condition of the suboxide. Hydrated suboxide will scarcely decompose a 2 per cent solution, even after standing. The threads, which bend at a sharp angle, usually do so at 60° or 120°; other threads, however, are symmetrically curved, but, especially in strong solutions, they are given to twisting about in every direction, and generally terminate in irregular knobs of silver. As a rule a thread continues to grow of the same thickness as it commenced, but it sometimes enlarges for a while into a flat plane, or becomes encrusted for some distance with small crystals of silver. When the solution is very nearly exhausted of silver, fine arborescent forms appear; but with the suboxide there are never produced the fern-leaved forms, or hexagonal plates, or the other distinctly crystalline structures which characterise the growth from metallic copper. During the reaction the suboxide is changed into black protoxide and metallic copper, which dissolves; and the change will take place as well with the acetate and sulphate as the nitrate. If a mixture of suboxide and metallic copper be employed, not only do the distinctly crystalline and the filiform forms make their appearance, but strange intermediate forms come into existence.

"*Apparatus for Measuring the Electrical Resistance of Liquids.*" By Prof. REINOLD.

The apparatus consists of two bottles connected by a horizontal tube. The whole is filled with the liquid to be examined and immersed in water, by which means, and by thermometers inserted in each bottle, the temperature may be regulated and accurately ascertained. The electrodes are platinum plates, one dipping into each bottle. Two fine tubes terminate near the ends of the connecting tube, and electrodes are fitted into them at some distance from the ends: by connecting these to a quadrant electrometer, or a condenser and galvanometer, the difference of potential between the ends of the tube can be compared with that at the ends of a known resistance in the same circuit.

"*On Chromatic Photometry.*" By Capt. ABNEY and Lieut.-Col. R. FESTING. (This paper had been previously communicated to the Royal Society.)

A series of experiments have been made by the authors to determine the comparative luminous effect of different parts of the spectrum. A monochromatic light from any part of the spectrum of the electric arc was obtained by a method devised by Capt. Abney, and previously described by him to the Society [Physical Society, June 27, 1885]. The photometric effect at different parts of the spectrum was compared with that due to a candle at different distances by Rumford's photometer. In using this it was found best to place the candle in a given position, and obtain a balance by moving the slide upon which the spectrum was formed, and through a slit in which part of the light was allowed to pass, rapidly to and fro. For each position of the candle there are thus two corresponding positions of the slit. From the results of these observations a curve may be drawn showing the luminosity at different points. From the method by which it is obtained it is evident that the curve of one observer is not directly comparable with that of another, since a deficiency of perception in any part of the spectrum would affect the light of the candle as well as that examined. Since, however, the curves obtained by a great number of persons coincide very closely with those obtained by the authors, they have felt justified in adopting them as the normal curves. In the case of the electric arc the normal curve attains a maximum rather nearer the red end of the

spectrum than the blue. Assuming the normal curve, any other curve may be compared with it by increasing or decreasing its ordinates so that no part of it shall lie without the normal curve: in curves thus obtained, several of which were shown, deficiency in colour perception is often very clearly marked. By the use of two or more slits in the movable slide experiments were made upon mixtures of colours, and it was found in all cases that the luminous effect of a mixture of colours was the sum of the luminous effects of its components. It was also found that the colour of the comparison and the quantity of light admitted to form the spectrum were without effect upon the form of the curve. Light from the sun and from an incandescent lamp were similarly examined, though it should be observed that the result for sun-light differs notably from that given by Maxwell. An examination has also been made by light after passing through a turbid medium, and an expression of Lord Rayleigh's—

$$I' = Ie^{-x\lambda^{-4}}$$

where I is the original radiation, I' that after passing through the medium, λ the wave-length of the light, and x a constant depending upon the medium, has been closely verified.

CORRESPONDENCE.

"AN IMPORTED ART."

To the Editor of the Chemical News.

SIR,—As a chemist fairly conversant with the "literature" upon the preparation and characters of the mineral colours, I beg to ask—in the interest both of chemists and artists—for your kind permission to add a few words to the notice of Mr. H. C. Standage's "Artists' Manual of Pigments" (CHEMICAL NEWS, vol. liii., p. 118).

Of the actual value of the information contained in the volume in question there can be, as your reviewer remarks, no manner of doubt, inasmuch as I find it mainly consists of a long series of unacknowledged extracts, direct and indirect,—mostly direct,—from the valuable and well-known edition of "Field's Chromatography," by Salter, published by Messrs. Winsor and Newton in 1869. We are thus afforded interesting evidence of the progress of an art amongst us which—like the Colorado beetle—we have hitherto fondly thought indigenous to America, viz., that of the author whose "works" may be said to be the result of "*moments of abstraction.*"

The extent of the wholesale appropriation in the book before us is remarkable. In his short preface Mr. Standage makes no mention whatever of the sources of his information, nor of his indebtedness to any text-book or authority upon the subject. The general reader will naturally infer that the pages which follow are in some part chronicles of the author's labours, or that the letterpress, at least, is original. Upon examination, however, they prove to be—so far as the colours described are concerned—a curious and interesting, if not a very ingenious, mosaic, consisting almost entirely of paragraphs, sentences, phrases, and obvious paraphrases, taken direct from Field's volume: these are sparingly interspersed with a few at present unidentified sentences, which, from not having been traced to any other source, and from their frequent inaccuracy, I am inclined to attribute to Mr. Standage himself.

Let anyone who may think this an exaggeration carefully compare, as I have this afternoon done, the ten pages devoted to green pigments with the same section in "Field's Chromatography," and it will be found that no less than seven pages are "mosaiced" direct; paragraphs and sentences inserted verbatim; sentences clipped, inverted, and transposed, linked together or separated under fresh headings. Half a page is occupied by an *acknowledged* quotation from Bouvier, and the balance is composed of such obvious "remarks," "conditions of permanency," "tests for adulterations," &c., as can be inferred or paraphrased from the foregoing.

Turning thence, at haphazard, I opened the leaves at "Orient Yellow"—reprinted entire; "Mars Red," ditto; "Carmine," part reprint, part mosaic; and so on with all the other colours I have compared. This, too, with only one pair of inverted commas to a ten-line reprint (viridian), which, however, has no accompanying reference. In the whole book Salter's name is only mentioned twice, in connection with some trivial fact, whilst that of Field is honoured by exclusion. In one of the final chapters the student is referred to various works, from which more precise details may be obtained wherewith to satisfy the cravings of the Science and Art Department Examiner; yet here also all mention of "Field's Chromatography" is rigorously—or, as the author remarks in a similar passage, "vigorously"—excluded.

The author's scientific status may be gauged by his *naïve* remark on the now almost universally accepted theory of primary colours, and of the secondary nature of yellow. He says:—"I cannot here enter into the question of which colours should be considered as true primaries, but from my own knowledge of colour science I remain steadfast to the old original theory of *red*, *yellow*, and *blue* being the three primaries."

The value of the original sentences which embellish the work, and serve to mortar together the more solid paragraphs of information, may be gathered from the following, culled in addition to those noticed by your reviewer:—"*Venetian ochre;* sulphate of iron prepared by calcining sulphate of iron." Venetian ochre is, of course, Fe_2O_3. "Red ochre, usually a sulphate of iron, or ferric sulphate": *usually* peroxide of iron also. "Vermilion . . . must not be used with iodine, since it does not dry quickly." (!) Who, outside of Hanwell, *would* use iodine, or even an iodide,—not excepting HgI_2,—in painting a picture! "Thénard's blue, a salt of calcium calcined with alumina or oxide of tin": in reality stannate of cobalt; and this *gem*—"Baryta White: in composition it consists of 137 equivalents of barium, 32 of sulphur, and 64 of oxygen; the constituents in these proportions constitute the *neutral* sulphate of baryta. *Note.*—Sometimes this white is not entirely freed from sulphuric acid, in which case it has two equivalents of hydrogen, and is known as the acid sulphate of baryta." Really! If Mr. Standage refers to the compound $BaH_2(SO_4)_2$, I may remind him that it is only produced in small quantities by prolonged immersion of an insoluble barium salt in concentrated sulphuric acid, and is immediately decomposed by water. These samples of chemical knowledge are unfortunate if we judge them by a sentence in the Preface:—"This ignorance (of the modern artist) is due to his being practically unacquainted with the chemical nature and qualities of his pigments and vehicles."

In leaving all expressions of the value of the "Artists' Manual of Pigments" to the readers of it and of these few lines, I cannot but recall Dr. Johnson's famous *mot* on a like occasion:—"There is much in your book, sir, which is both new and true; but that which is new is not true, and that which is true is not new."—I am, &c,

H. LIVINGSTONE SULMAN.

Laboratory, 14, Chetwynd Road, N.W.,
March 17, 1886.

THE SPECTRA OF ERBIA.

To the Editor of the Chemical News.

SIR,—In reference to Mr. Crookes's observation in his recent paper on erbia, that this earth when illuminated with sunlight or electric light gives a spectrum with dark bands, I should like to state that I have frequently noticed the same effect with many solid compounds of

erbium and didymium, and ordinary daylight suffices to give a very distinct spectrum of dark lines similar in every respect to the absorption spectrum of the compounds in solution. The spectra were only examined with a small pocket-spectroscope, and a closer comparison would probably reveal some slight differences.

I believe it is better known that the two earths when heated to redness (best with phosphoric acid on a platinum wire in a Bunsen burner) give spectra of bright lines corresponding to the dark lines of their absorption spectra.

These two phenomena are what were to be expected from the abnormal absorption and the accepted laws of radiant energy.—I am, &c.,

T. S. HUMPIDGE.

Aberystwith, March 22.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—Having been desired, at examination, to state what products would be obtained by the action of phosphorus trichloride upon glacial acetic acid, I answered that the reaction gave acetyl chloride and phosphorus acid.

Being afterwards told that I should have included hydrochloric acid, I referred to the text-books, beginning with the most recent.

Morley (1886) gives no HCl in the equation (in which acetic acid is $C_2H_3O.OH_2$), but directs that the mixture be "warmed until no more hydric chloride escapes." Remsen (1885) gives no HCl. Armstrong (1884), Roscoe and Schorlemmer (1881), Fownes-Watts (1877), Schorlemmer (1873), Frankland (1872), also give no HCl.

Miller (1869) does give HCl as one of the products, as does Watts's translation of Gmelin (1856), on the authority of Béchamp (*Comptes Rendus*, 1855).

Thorpe (1880, *Journ. Chem. Soc.*, xxxvii., 186) gives the equation $3C_2H_4O_2 + 2PCl_3 = 3HCl + P_2O_3 + 3C_2H_3OCl$, and his experiments were confirmed by those of John Muir.

I shall be thankful if any of your readers can tell me where to find the account of experiments which contradicted those of Thorpe and Muir and led Roscoe and Schorlemmer, Armstrong, Remsen, and Morley to omit the HCl from their equations.—I am, &c.,

AN OLD STUDENT.

PS. I find that in "Miller's Organic Chemistry," edited by Armstrong and Groves in 1880, the equation given by Miller in 1869 has been corrected (?) by omitting the HCl.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 10, March 8, 1886.

Isomeric States of Chromium Sesquichloride.—A. Recoura.—The author here describes the grey modification. He recognises two isomeric states of the sesquichloride; the green, with which is connected the anhydrous violet form, and, on the other hand, the grey. If dissolved in water these two varieties constitute two extreme states which may be transformed into each other by passing through all the intermediate conditions. The blue-grey solution is the stable state for dilute solutions and the green for those which are concentrated.

A Compound of Methylic Alcohol and of Copper Sulphate.—M. de Forcrand.—If pure anhydrous methylic alcohol is allowed to react in the cold upon anhydrous copper sulphate a green colour quickly appears either in the mass of copper sulphate or in the liquid. This colour is due to a compound of the two bodies slightly soluble in an excess of methylic alcohol. The higher homologues of methylic alcohol do not form similar combinations.

Action of Ammonia and Water upon Chloroform.—G. André.—The author obtains ammonium formiate and hydrochlorate and carbon monoxide. If the temperature has not exceeded 180° there remains a portion of unaltered chloroform.

Action of Picric Acid upon Turpentine and Thymene.—M. Lextreit.—Picric acid combines with oil of turpentine, forming a compound which approximates to the borneols. With thymene the result is similar.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 4, February 15, 1886.

A Substance sold under the Name of Crystallised Hopeine.—A. Petit.—This substance, though having a slight odour of hops, has in its appearance, its crystalline form, and in all its reactions a close resemblance to morphia.

Ureometer.—F. Bellamy.—This instrument cannot be described intelligibly without the aid of the accompanying illustration.

Study of the Principal Red Colouring-Matters of Coal.—M. Frehse.—The author's point of view is the recognition of coal-tar reds as used for the colouration of wines, bon-bons, &c. He gives methods for detecting ponceau, soluble red, roccelline, "purple," Bordeaux red, violet I, orchil red, the croceines, ponceau A, acid magenta, ordinary magentas, with garnet, grenadine, cerise, roseine, geranium, the eosines, safranine, rosaline, Biebrich red, rose Bengale, Magdala red.

Experiments on Fatty Matters.—MM. Dubois and Padé.—Already noticed.

Note on the Determination of Oxygenated Water.—C. Blarez.—The author refers to a method and an apparatus for this purpose proposed by M. de Thierry, and remarks that he has for some time utilised this reaction for the same purpose.

Ferric Chloride with Potassium Ferricyanide as a Reagent.—MM. Hager and Reeb.—Fifteen drops ferric chloride (sp. gr. 1·280) and 15 drops of a saturated solution of potassium ferricyanide are mixed with 60 c.c. of water, acidulated with 5 drops of hydrochloric acid (sp. gr. 1·061). If a reducing agent is brought in contact with this test the colour turns from red to blue in consequence of the formation of Turnbull's blue. The solvents such as alcohol, ether, chloroform, amylic alcohol, benzol, have no effect. The blue colour should appear instantly, or at furthest within eight to ten minutes. The presence of morphine in a salt of quinine is thus shown with great ease. The author gives tables of the substances with which it reacts and of those with which it is indifferent.

Toxicity or Non-Toxicity of the Compounds of Copper.—M. du Moulin.—Doses of ½ grm. to 1 grm. of basic copper acetate were administered daily to dogs and rabbits for six weeks without producing poisoning. Copper oxide and carbonate have been also administered to rabbits for a year without producing any appreciable injury.

Detection of Small Quantities of Albumen in Urine.—H. Bretet.—The author finds that the nitric acid test when it gives negative results is not always satisfactory. He therefore proposes that Méhu's test should also be employed, *i.e.*, the urine, which if not distinctly acid should be first acidulated with a few drops of acetic acid, is saturated with sodium sulphate, and coagulation is then effected by applying heat only to the upper part of the liquid.

Influence of Bile and Biliary Acids upon the Digestive Action of Pepsine and Trypsine.—MM. Chittenden and Cummins.—From the CHEMICAL NEWS.

Hæmostatic Liquid.—M. Rothe.—The young shoots of the nettle are extracted with alcohol at 60 per cent.

Disinfection of Rooms.—M. Koenig.—The author recommends mercuric chloride. The windows, chimney, &c., are carefully closed up and 50 grms. mercuric chloride are placed in any suitable vessel, which is then set on a pan of burning charcoal, the operator immediately leaving the room and closing the door. After about four hours he re-enters, with a cloth over his mouth and nose, and throws open the windows. After some hours of ventilation a slight stoving with sulphur is made to follow, which neutralises any remnants of mercury. This process not merely disinfects but destroys all kinds of vermin.

Separation of Strychnine from the Animal Organism.—M. Plúgge.—Sonnenschein's reagent (sulphuric acid and cerous oxide) is the most sensitive reagent for strychnine, being capable of detecting 0·0000005 grm. of strychnine. Strychnine passes into the urine in great part undecomposed. The elimination of strychnine from the animal system requires a long time. A week after a single dose has been taken traces of it may be detected in the urine.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiv., Part 11.

Principles and Limits of the Purification of Putrid and Putrescible Waters.—Prof. Dr. J. König.—The author proposes to allow foul waters to trickle down and through wire nets, thus obtaining results fully equal to those of irrigation over meadows. He likewise passes furnace- and chimney-gases through sewage, &c., as disinfectants.

The Dephosphorisation of Iron by the Thomas Process, and its Significance for Agriculture.—Dr. M. Fleischer.—The bulk of the phosphoric acid in these slags is in combination with lime; a small portion possibly with magnesia. All the phosphoric acid may be extracted by continued treatment with water containing phosphoric acid, whilst the iron remains practically undissolved. Thomas slags give off far more phosphoric acid to soils than do apatites, coprolites, and other natural phosphatic minerals.

Gases in Floating and Submerged Leaves. — N. Gréhant and J. Peyron.—From the *Comptes Rendus*.

Experiments in Vegetable Physiology. — Prof. H. Hellriegel.—The author has examined whether the degree of concentration in which nitrogen occurs in the nutrient liquids of the soil has an essential effect upon its utilisation. The crops obtained in the experiments were found to depend solely on the quantity of the nitrogen present.

Experiments on the Uninterrupted Cultivation of Wheat and Barley at Woburn.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

On a Ferment which inverts Cane-Sugar. — A. Ladureau. — The author points out the necessity of cleansing the saccharometer tubes with dilute hydrochloric acid, phenol, or salicylic acid. Washing with water is not sufficient.

Vol. xiv., Part 12.

On Nitrogenous Organic Compounds in Arable Soils. — Dr. G. Loges. — On evaporating hydrochloric extracts of arable soils, even though very poor in humus, the author invariably obtained black residues. On analysis these were found to be organic nitrogen compounds.

Weathering of Sandstones. — Julius Stocklasa.— Sandstones consist of grains of silica cemented together with calcium carbonate and calcium and aluminium silicates. Magnesium and ferrous carbonate were present only to a small extent. By the continued action of the atmosphere the cement is washed away, and the free silica remains in disconnected grains.

On Certain Plant Destroyers.—An entomological paper.

Importance of the Cellulose Fermentation for the Nutrition of Animals.—W. Henneberg and F. Stohmann. Cellulose is a food of great value, 266 parts being equal in value to 100 parts of fat.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Vol. xii., December, 1885.

Report given in by M. Aimé Girard on behalf of the Committee of Chemical Arts on the Researches of M. Livache with Reference to the Drying Power of Oils.—M. Livache has devised a new process for preparing what used to be called "boiled oils." He finds that if finely divided metallic lead is moistened with linseed oil oxygen is taken up to the extent of 14 to 15 per cent without the aid of fire, and consequently without danger. This reaction distinguishes the drying oils from the non-drying class.

Series 4, Vol. i., No. 1, January, 1886.

This issue contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Hard Varnish.—Can any of your readers tell me where I can obtain a varnish which will stand a high temperature, such as boiling water, without softening or cracking.—H.C.

MEETINGS FOR THE WEEK.

MONDAY, 29th.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "Petroleum and its Products," by Boverton Redwood, F.C.S.
TUESDAY, 30th.—Institution of Civil Engineers, 8
—— Chemical, 8. (Anniversary.) Election of Office Bearers and Council.
—— Royal Institution, 3. "The Function of Circulation," by Professor Arthur Gamgee, M.D., F.R.S.
WEDNESDAY, 31st.—Society of Arts. "Methods for Rendering the Blind Self-supporting," by T. R. Armitage, M.D.
THURSDAY, April 1st.—Royal, 4.30.
—— Royal Institution, 3. "Electro-Chemistry," by Prof. Dewar, F.R.S.
—— Chemical, 8. (1). "The Determination of Boiling-points," (2). "The Action of a Red-heat on Chloroform," by Prof. W. Ramsay and Dr. S. Young. "The Use of the Electric Light to influence Chemical Change," by Dr. H. E. Armstrong, F.R.S. "Some Sulphur Compounds of Barium," by S. H. Veley.
FRIDAY, 2nd.—Royal Institution, 9. "Telescope Objectives; their Preparation and Testing," by Howard Grubb, F.R.S., F.R.A.S.
—— Society of Arts, 8. "The History of Archæology in India," by James Gibbs,, C.S.I., C.I.E.
—— Geologists' Association, 8.
SATURDAY, 3rd.—Royal Institution, 3. "The Astronomical Telescope," by Howard Grubb, F.R.S.
—— Society of Arts, 3. "Electricity," by Professor George Forbes, M.A., F.R.S.E.

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SUGGESTIONS AS TO THE CAUSE OF THE PERIODIC LAW, AND THE NATURE OF THE CHEMICAL ELEMENTS.*

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The truth of the Periodic Law, as enunciated by Newlands, Mendeljeff, and Lothar Meyer, is now generally allowed by most chemists. Nevertheless but little has been done towards attaining a reasonable explanation of the Law.

The object of the present paper, therefore, is to offer a few suggestions on this subject.

The Periodic Law not only throws considerable light on many relationships and points of analogy which had previously been observed, but has also led to the discovery of numerous others of both theoretical and practical importance, and has opened up views of the elements and their compounds which have been of great service in attaining a correct knowledge of their mutual relationships.

Granting the truth of the Periodic Law, we cannot help theorising as to its cause, and thence, by a natural step, as to the nature of the elements themselves. Even long before the discovery of the law many chemists—more especially Gladstone, Cooke, Pettenkofer, Odling, Kremers, and Dumas—had pointed out certain numerical relationships existing between the atomic weights of bodies belonging to a given group, and had thence been induced to seek for explanations of such relationships. These chemists hence supposed that the elements belonging to the several natural groups were not primary, but were made up of two or more simpler elements. These considerations, as to the compound nature of the elements, were very ably discussed, more especially by Dumas and Gladstone (*Phil. Mag.* (4), v., 313; *Comptes Rendus*, xlv., 709, 731; xlvi., 951; xlvii., 1026). A perusal of their papers on this subject is extremely interesting in view of the more recent discoveries of Newlands, Meyer, and Mendeljeff, and show how nearly the law was detected prior to its first enunciation by Newlands in his "Law of Octaves."

The views of Dumas and Gladstone may be expressed somewhat as follows:—The atomic weights of any group of closely allied elements, when written down in numerical order, form an arithmetical progression represented by $a+xd$, in which a is the first term and d the common difference. Thus in the case of the magnesium group we have—

	Be	Mg	Ca	Sr	Ba
$a=8$ ..	8	24	40	88	136
$d=16$ ..	a	$a+d$	$a+2d$	$a+5d$	$a+8d$

Now this relationship, as pointed out by both Gladstone and Dumas, is exactly similar to that which holds in the case of the homologous series of organic chemistry. For example:—

Methyl	$CH_3=15=a$
Ethyl	$C_2H_5=29=a+d$
Propyl	$C_3H_7=43=a+2d$
&c.	

In other groups of elements, however, the relations are not so simple, and it is necessary to assume such a complex expression as—

$$a+xd+xd'+xd''+\&c.$$ Thus:—

$a=19$ ..	F	Cl	Br	I
$d=16{\cdot}5$..	19	35·5	80	127
$d'=28$ ..	a	$a+d$	$a+2d+d'$	$2a+2d+2d'$

The conclusions of these chemists, however, were more or less fragmentary, and referred only to particular and isolated groups of elements. At that time the Periodic Law had not been propounded, and more general conclusions were therefore impossible, for the *general* application of the above facts would have necessarily implied a discovery of the Law prior to that made by Newlands.

In the light of the Periodic Law I wish to make a general extension of the fragmentary conclusions of Dumas. But I propose to arrive at this extension from a totally different standpoint and in a totally different way. It is an extension to which I have been led quite independently of the previous suggestions of Dumas, Gladstone, and others. In brief, what I wish to do is to bring into juxtaposition the Periodic Law, and an extended generalisation of the analogy of the elements to the alcohol radicles. At the same time I should wish my conclusions to be considered rather as *endeavours* after truth than the truth itself.

These conclusions are based on the relationships which I have observed to obtain between certain physical properties and the atomic weights of the elements and those of their compounds.

The relationships to which I refer have in part been published in various periodicals, but I wish more especially to direct attention to three of these, viz.:—

1. In this paper (*Phil. Mag.* (5), xviii., 1) a careful comparison was made of the melting- and boiling-points, and heats of formation, of the normal *halogen* compounds of the *elements*, and it was shown that certain well-defined relationships existed between these properties,—relationships which were dependent in a marked manner on the atomic weight of both the positive element and the halogen.

2. This paper (*Phil. Mag.* (5), xx., 259) dealt in a similar manner with some of the physical properties of the normal *alkyl* compounds (methides, ethides, &c.) of the elements, and it was shown that the *same relationships* obtained as in the case of the corresponding halogen compounds.

3. In this paper (*Ibid.* (5), xx., 497) it was shown that both the normal halogen and normal alkyl compounds of the hydrocarbon radicles* exhibit (with one exception, see Table I.) relationships similar to those of the corresponding compounds of the elements.

The relationships which were found to exist among all the above four classes of compounds were very numerous, but there were ten which were especially of importance; and for the purpose of giving some idea of the weight of the evidence which these relationships furnish, it will be well to state, in the following table, the number of cases in which they have been applied in each of the above classes of compounds, and the number of exceptions:—

	No. of cases in which the rules have been applied.	Number of exceptions.
I. Halogen compounds of the elements	3248	180=5·5%
II. Alkyl ditto..	942	54=5·7 ,,
III. Halogen compounds of the hydrocarbon radicles	877	11=1·2 ,,
IV. Alkyl ditto..	1110	60=5·4 ,,
Total	6177	305=5·0 ,,

For the reasons pointed out in my first paper (*q. v.*) 5 per cent of exceptions is very small, and is due chiefly

* A Paper read before the British Association, Aberdeen Meeting.

* For the definition of these radicles see Table IX.

to errors in the experimental melting- and boiling-points; thus no less than forty-five of the above exceptions are due to the boiling-point of propane being taken too high.

Examples of the kind of relationships referred to are given in the following Tables (I. to VII.). The arrows show the direction in which the melting- or boiling-point alters with the atomic weight. In the case of the halogen compounds of the elements, both calculated (*Phil. Mag.* (5), xviii., 1) and experimental data are given, in order that the Tables may be more complete.*

* So far as the determinations of the molecular magnetic rotations of the halogen compounds of the hydrocarbon radicles, made by Dr Perkin (*Chem. Journ.*, 1884; *Trans.*, 577), will allow a conclusion to be drawn, these physical constants also exhibit relationships similar to those given below in the case of the melting- and boiling-points. If this be true it is very probable that the molecular magnetic rotations of the halogen compounds of the elements would behave in a similar manner.

TABLE I.—*Relation* 1 (*Periodicity*).

X =	Cl	Br	C_2H_5	Cl	Br	CH_3	= X
	M.-pt.	B.-pt.	B.-pt.	B.-pt.	B.-pt.	B.-pt.	
↑ LiX_1	870	820	—	—	—	—	—
BeX_2	874	874	459	—	—	—	—
BX_3	210	271	369	—	—	—	—
CX_4	231	364 (?)	—	350	462	282	CX_4 ↑
NX_3	200	244	362	334	424	256	$(CH)X_3$
OX_2	199	237	308	315	370	245	$(CH_2)X_2$
FX_1	189	218	283	249	278	Gas	$(CH_3)X_1$
↑ NaX_1	1045	981	—	—	—	—	— ↓
MgX_2	981	971	—	460 (?)	—	—	$(C_2)X_2$
AlX_3	340	366	467	360	435	309	$(C_2H)X_3$ ↓
SiX_4	205	260	425	411	488	325	$(C_2H_2)X_4$ ↑
PX_3	200	252	401	367	462	293	$(C_2H_3)X_3$
SX_2	199	240	364	345	393	265	$(C_2H_4)X_2$
ClX_1	198	229	285	285	312	245	$(C_2H_5)X_1$
↑ CuX_1	707	777	—	—	—	—	$(C_3H)X_1$ ↓
ZnX_2	535	667	391	351	—	314	$(C_3H_2)X_2$
GaX_3	346	378	—	402	457	343	$(C_3H_3)X_3$ ↓
$EkaSiX_4$	—	—	—	447	513	360	$(C_3H_4)X_4$ ↑
AsX_3	244	295	432	415	476	330	$(C_3H_5)X_3$
SeX_2	237	276	381	366	411	299	$(C_3H_6)X_2$
BrX_1	229	251	312	315	339	265	$(C_3H_7)X_1$
↑ AgX_1	724	700	—	—	—	323	$(C_4H_3)X_1$ ↓
CdX_2	814	844	—	—	—	355	$(C_4H_4)X_2$
InX_3	377	408	—	—	—	358	$(C_4H_5)X_3$ ↓
SnX_4	254	303	454	—	—	380	$(C_4H_6)X_4$ ↑
SbX_3	345	363	432	—	487	364	$(C_4H_7)X_3$
TeX_2	337 (?)	354 (?)	373	386	431	333	$(C_4H_8)X_2$
IX_1	298	309	345	339	361	299	$(C_4H_9)X_1$
↑ AuX_1	—	—	—	—	—	—	$(C_5H_5)X_1$ ↓
HgX_2	561	517	432	419	—	360	$(C_5H_6)X_2$
TlX_3	477	508	—	473	—	387	$(C_5H_7)X_3$ ↓
PbX_4	338	372	473	508	548	404	$(C_5H_8)X_4$ ↑
BiX_3	503	480	—	454	—	381	$(C_5H_9)X_3$
—	—	—	—	417	453	365	$(C_5H_{10})X_2$
—	—	—	—	371	391	333	$(C_5H_{11})X_1$

TABLE II. *Relation* 2 (*Boiling-points*).

X =	Cl	Br	I	CH_3	C_2H_5	a-C_3H_7
SnX_4	389	474	568	351	454	498
SbX_3	496	549	693	354	432	—
AlX_3	453	533	623	403	467	543
HgX_2	576	592	622	367	432	464
IX_1	373	390	473	317	345	375
$(C_3H_4)X_4$	447	513	—	360	—	—
$(CH)X_3$	334	424	—	256	370	—
$(C_3H_5)X_3$	402	457	—	343	—	—
$(C_2H_4)X_2$	345	393	a.453	274	344	398
$C_5H_{11}X_1$	371	391	416	333	365	398

TABLE III. *Relation* 3 (*Boiling-points*).

X =	Cl	Br	I	CH_3	C_2H_5	Cl	Br	CH_3	C_2H_5	= X
↓ FX_3	351	444	575	314	401	334	424	256	370	CHX_3
AsX_3	405	493	677	—	432	367	462	293	—	$(C_2H_3)X_3$
SbX_3	496	549	693	354	432	415	476	330	—	$(C_3H_5)X_3$
BiX_3	703	749	—	—	—	—	487	364	—	$(C_4H_7)X_3$
—	—	—	—	—	—	454	—	381	—	$(C_5H_9)X_3$ ↓

TABLE IV. *Relation 4.*

	Br—Cl M.-pt.	I—Br M.-pt.	Et—Me B.-pt.	Pr—Et B.-pt.	Br—Cl B.-pt.	I—Br B.-pt.	Et—Me B.-pt.	Pr—Et B.-pt.	
Na	—64	—80		—	—	—	—	—	$(C_3H)^i$
Mg	—10	—75	—	—	—	—	—	—	$(C_3H_2)^{ii}$
Al	26	32	64	56	55	—	—	—	$(C_3H_3)^{iii}$
Si	55	133	122	61	66	—	—	—	$(C_3H_4)^{iv}$
P	52	76	87	—	61	—	—	—	$(C_3H_5)^{iii}$
S	41	75	54	41	45	49	60	51	$(C_3H_6)^{ii}$
Cl	31	69	36	34	24	29	37	33	$(C_3H_7)^i$

TABLE V.—*Relations 5 and 6 (Boiling-points).*

	Br—Cl	I—Br	Et—Me	Pr—Me	Br—Cl	I—Br	Et—Me	Pr—Me	Normal primary.
Diff. of at. wts.	44·5	47	14	28	44·5	47	14	28	
Cl	46	87	36	70	29	37	—	—	CH_3
Br	45	59	35	67	27	33	—	—	C_2H_5
I	17	83 (?)	28	58	25	31	37	70	C_3H_7
Si	95	137	122	183	22	30	33	60	C_4H_9
Sn	86	94	103	147	22	27	27	54	C_5H_{11}
Pb	—	—	40	—	22	26	27	51	C_6H_{13}
Zn	19	—	72	113	20	22	24	48	C_7H_{15}
Hg	16	30	65	97	20	—	24	46	C_8H_{17}

TABLE VI.—*Relations 7a and 7b (Boiling-points).*

(I.)	Diff. of at. wts. of elements in (I.).	Cl	Br	I	CH_3	C_2H_5	a-C_3H_7	Diff. of at. wts. of elements in (I.a).	(I.a).
As—P	44	54	49	102* (?)	82 (?)	19	—	89	Pb—Sn
Sb—As	47	91	56	16	48	29	12	90	Sn—Si
Sb—P	89	145	105	118*	130	48	—	179	Pb—Si
Bi—Sb	90	207	200	171	28	27	25	44·5	Br—Cl
Bi—As	135	298	256	187	40	33	31	47·0	I—Br
Bi—P	179	352	305	289	68	60	56	91·5	I—Cl
C_4H_9—C_3H_7	14	32	29	28	37	33	27	14	C_4H_9—C_3H_7
C_6H_{13}—C_4H_9	28	55	55	51	60	54	51	28	C_6H_{13}—C_4H_9
C_6H_{13}—C_3H_7	42	87	84	79	97	87	78	42	C_6H_{13}—C_3H_7
C_8H_{17}—C_4H_9	56	105	103	91	111	102	97	56	C_8H_{17}—C_4H_9
C_8H_{17}—C_3H_7	70	137	132	119	148	135	124	70	C_8H_{17}—C_3H_7
C_8H_{17}—C_2H_5	84	171	164	149	177	172	156	84	C_8H_{17}—C_2H_5
C_8H_{17}—CH_3	98	207	198	179	—	201	193	98	C_8H_{17}—CH_3

* Boiling-point of PI_3 too low and boiling-point of AsI_3 too high.

TABLE VII.—*Relations 8 and 9 (Boiling-points).*

(I.)	Diff. of at. wts. of elements in (I.).	Cl	Br	I	CH_3	C_2H_5	a-C_3H_7
P—I	−96	−22	+54	+102	−3	+56	—
As—I	−52	+32	103	204	—	87	—
P—Br	−49	65	113	185	+37	89	—
Sb—I	−7	123	159	220	37	87	—
P—Cl	−4·5	111	158	202	65	116	—
As—Br	−5·0	119	162	287	—	120	—
As—Cl	+39·5	165	207	304	—	147	—
Sb—Br	40·0	210	218	303	77	120	—
Sb—Cl	84·5	256	263	320	105	147	—
Bi—I	83·0	330	359	—	—	—	—
Bi—Br	130·0	417	418	474	—	—	—
Bi—Cl	174·5	463	463	491	—	—	—
CH_2—C_8H_{17}	−99	−141	−106	−41	−177	−135	−97
C_2H_4—C_8H_{17}	−85	−99	−71	—	−148	−102	−70
CH_2—C_6H_{13}	−71	−91	−58	−1	−126	−87	−51
C_4H_8—C_8H_{17}	−57	—	—	—	−78	−48	−22
CH_2—C_4H_9	−43	−36	−3	+50	—	−33	0
C_2H_4—C_4H_9	−29	+6	+32	—	−37	0	+27
C_2H_4—C_3H_7	−15	38	61	—	0	+33	54
C_3H_6—C_3H_7	−1	74	94	125	+37	60	78
C_3H_6—C_2H_5	+13	108	126	155	—	97	111
C_5H_{10}—C_3H_7	27	—	—	—	94	111	123
C_5H_{10}—C_2H_5	41	—	—	—	126	148	156
C_5H_{10}—CH_3	55	—	—	—	—	177	193

(To be continued).

A NEW SEWAGE PROCESS.

By A. McDONALD GRAHAM, F.C.S.

Some years since, when acting as chemical adviser on a large colliery in the North of England, and being much interested in obtaining a thoroughly trustworthy method of estimating the sulphur in coal and coke, I was led to examine the process proposed by Mr. Teikichi Nakamura, student of the Imperial College of Engineering, Tôkiô, Japan, and described in the *Journal of the Chemical Society* for 1879.

In order to save your readers the trouble of reference I think it would be better to insert Mr. Nakamura's own description of the process, which is as follows:—"The process consists in heating the coal below a red-heat in contact with alkaline carbonates, by which the coal, whether bituminous or not, rapidly undergoes—without evolution of smoke—complete atmospheric oxidation in a manner hardly to have been expected. The details of the method are as follows:—I take 3 or 4 parts of sodium carbonate to 1 part of coal in very fine powder. Intimately mix, in a large platinum dish or crucible, with a dry glass rod, and heat the mixture in the dish or crucible, loosely covered, at first so gently as not to volatilise hydrocarbons,—that is, so that no smell, or only a very faint aromatic odour, is observable,—a matter which is much easier of execution than might be supposed. Keep at a low temperature for some time; then raise the heat by slow degrees, without letting it reach that of visible redness, until the surface, which is at first of a dark grey colour, becomes only faintly grey. No smoke or odorous gas should escape during the whole of the oxidation. When the surface becomes only faintly grey, raise the temperature to a faint red-heat and keep it stationary for about forty to sixty minutes, at the end of which time the mass will become almost perfectly white or reddish if the coal contains iron, from the complete combustion of the coal. The mass is then treated with water, filtered, and the sulphate is determined in the usual way. It is rather remarkable that coal, and even coke, is burned completely at so low a temperature. Alkaline carbonates seem, however, to have no chemical action, but to act simply mechanically. The spaces between the particles of the carbonates acting as chimneys, the oxygen wanted being of course taken from the air. The combustion travels from the surface towards the bottom. Stirring the mixture during the oxidation impedes the process instead of hastening it, probably by closing the passages left by the consumed coal. The alkaline carbonates unchanged to sulphate remain unaltered."

After a careful consideration of the above process, it occurred to me that this principle of slow oxidation might be made available for the production of a sewage precipitant in the first place, and also for burning off the precipitated organic matter and making the residual mud again of use for the purpose of defecating and clearing the sewage in those cases where the mud does not contain sufficient plant-food to make it of value as a manure, and after a number of experiments extending over several years I have succeeded in elaborating a process which is satisfactory to myself, and which works well in practice. In carrying out my experiments I have observed that when a large excess of pyrites are acted on by the process sulphurous anhydride is formed and passes off in the gaseous state, and sulphate of iron remains in the mixture. If any oxide is added to the mixture, such as oxide of zinc, iron, or manganese, then a sulphate of the metal is also obtained.

In order to obtain a good sewage precipitant by this process an oxide must be selected which will form a stable salt with sulphuric acid, and is not liable to peroxidise, and which can also be acted on any number of times; and it is absolutely necessary that this oxide should exist in large quantities, and be obtainable at a moderate price. Binoxide of manganese fulfils these conditions, and in order to form my sewage precipitate I take this oxide, and add to it iron pyrites in a fine state of division, more than sufficient to convert the whole of the oxide of manganese into sulphate. As a medium for conveying the oxygen of the air to the mixture I use about 5 parts of finely-divided clay to 1 part of manganese. This is cheaper than carbonate of soda, though somewhat slower in its action, and in the many experiments I have performed I have found that very few samples of clay are attacked during the operation. After well mixing the powdered binoxide with the pyrites and fine clay, I place them in a muffle furnace, and heat the mixture gently at first, and afterwards to incipient redness, or about 1000° to 1200° F. After heating for about three or four hours the oxidation will generally be found to be complete, and the whole of the manganese will be converted into sulphate, together with a part of the iron. The mass when cool should be sprinkled with water, and allowed to remain in a damp condition for a week or more.

Two chemists, of much experience as practical analysts, have examined the process quantitatively, operating upon 3 or 4 lbs. of the mixture, and have obtained excellent results.

In operating on the sewage the sulphates of manganese and iron may be used with a certain proportion of clay, which is a well-known defecator of sewage. Charcoal may also be associated with the manganese, &c., if the sewage is much discoloured. Should the sewage be acid, from the influx of chemical refuse or any other cause, it will be necessary to use a little lime; but in a general way the sewage will be found to be sufficiently alkaline to ensure the precipitation of the manganese and iron, and the constant use of lime should be avoided. An effluent water obtained by the addition of much lime to a sulphate of alumina or iron has been found by experience to generate sulphuretted hydrogen and other offensive gases.

The effect of clay in carrying down organic matter may be demonstrated by a simple experiment. Take 10,000 grs. of fresh urine, and, after allowing it to stand for two hours, agitate it well with 50 grains of clay previously dried and powdered. No alteration will be apparent in the urine at the close of the operation; but on carefully collecting the clay on a filter, and drying it at a temperature below 100° C., it will be found, by the soda-lime process, to contain about 4 to 5 per cent of ammonia. Of the action of the charcoal it is unnecessary to speak.

In order to convert the sewage mud into a useful precipitant it must first be dried. Formerly the drying process was attended with much difficulty and expense, but as the nature of the product to be treated has become better understood the drying difficulty has been to a great extent surmounted. It is found by experience that after such a precipitating medium as alumina, iron, or manganese has passed through the sewage, it has acquired a new property,—that of spontaneous heating when mixed with organic matter, &c. If, therefore, the mud obtained by the use of such precipitants on the sewage be deprived of superfluous water by means of a filter-press, and placed in heaps in a sheltered situation, a natural heating takes place, the thermometer frequently rising as high as 180° F. when inserted in the middle of the heap. This faculty of spontaneous heating has been attributed, and I believe correctly, to the small quantity of phosphoric acid recovered from the sewage by the precipitating medium. After this heating process has taken place the mud will be found to be in a dry and friable condition, and can be readily brought into a fine state of division. It should then be furnaced with sufficient iron pyrites to re-convert the manganese and iron into sulphates. The oxidation of the organic matter by this process is very complete, and not the slightest nuisance is caused by the operation.

Iron pyrites (smalls) are now practically unsaleable, and exist in enormous quantities. If copper pyrites are used arrangements can be made for recovering the copper. It is estimated that a ton of the precipitating mixture, containing about 15 per cent of the mixed salts of man-

ganese and iron, and 85 per cent of fine clay, can be prepared for about 16 shillings, and the mud can be regenerated for about 8 or 9 shillings per ton.

The effluent water produced by the use of the clay, sulphate of manganese, &c., is clear and free from smell. It will keep for any length of time in an open or close vessel without giving off unpleasant gases or developing organic germs.

2, Dermody Road, Lewisham, S.E.,
March 20, 1886.

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

(Continued from p. 148.)

c. Influence of Acid-Proteid Matter—(continued).

In the last series of experiments where 21·9 c.c. of B are used the amount of combined acid in the digestive mixture is but 0·00094 per cent HCl, so that where the smaller amounts of acid-reacting saliva are used the percentage amount of combined acid is very small indeed.

Increasing the amount of saliva used, and thereby the percentage of acid-proteid matter, brought us finally to a point where the acid-proteid matter failed to stimulate the diastatic action of the ferment, and even began to show a tendency to retard its action.

The following series of experiments, using saliva wholly undiluted, illustrates this point:—

Series XVI.

100 c.c. of filtered saliva were neutralised, requiring 32 c.c. 0·2 per cent HCl = A.

52·8 c.c. A = 40 c.c. of the original saliva required 12·15 c.c. 0·1 per cent HCl to combine with the proteids, making saliva B; the fluid was distinctly acid to litmus, and contained 0·0187 per cent combined acid. Three digestions were made with both A and B, using quantities of the fluids equal to 20, 10, and 5 c.c. respectively of the original saliva.

		Wt. Cu in one-eighth.	Total amount sugar.
26·4 c.c.	A ..	0·1083 grm.	0·4408 grm.
32·48	B ..	0·1065	0·4336
13·2	A ..	0·1024	0·4168
16·24	B ..	0·1087	0·4424
6·6	A ..	0·0948	0·3864
8·12	B ..	0·1031	0·4192

		Starch converted.	Combined HCl in the 100 c.c. digestive mixture.
26·4 c.c.	A ..	39·68 p.c.	0
32·48	B ..	38·96	0·00608 p.c.
Decrease ..		0·72	
13·2 c.c.	A ..	37·52 p. c.	0
16·24	B ..	39·73	0·00304 p. c.
Increase ..		2·21	
6·6 c.c.	A ..	34·79 p. c.	0
8·12	B ..	37·74	0·00152 p. c.
Increase ..		2·95	

In this series of experiments, where the percentage of combined acid in the digestive mixture is much greater than before, the same increase in diastatic action is noticed. With the largest quantity of saliva, however, where the amount of combined acid is 0·006 per cent, we seem to have reached a point where the acid-proteid matter ceases to stimulate and begins to retard the action of the ferment. That this is actually the case we have proved by another experiment confirmatory of the preceding one, using in the digestion, however, 2 grms. of starch instead of 1.

Thus, while an amount of neutral saliva equal to 20 c.c. of the original secretion converted 39·08 per cent starch into sugar, the same amount of saliva having all of its proteid matter combined with acid converted under the same conditions 38·21 per cent of the starch, a decrease of 0·87 per cent; in this case, however, the amount of combined acid present in the 100 c.c. of digestive mixture was 0·008 per cent.

It thus seems plainly proven that up to a certain percentage the presence of acid-proteid matter in the saliva tends to decidedly stimulate its diastatic action. We cannot therefore agree with Langley and Eves that ptyalin acts best in every instance in a neutral solution, for our results certainly show an increased action of the ferment in the presence of the acid-proteids, except where the latter are present in comparatively large amount.

The only possible fallacies which suggest themselves here are traces of undetectable alkali in the starch and the presence of phosphates of calcium or magnesium. This result, moreover, makes clear many statements previously recorded which would otherwise be difficult of explanation. Thus it has been recorded by Astaschewsky* that the saliva of the parotid gland possesses a very faint acid reaction, and that the maximum of the diastatic action of parotid saliva corresponds with the strongest acid reaction; but in these observations doubtless the acid reaction was in every case due to acid proteids, and not to free acid. Again it was found by one of us† that the presence of 0·005 per cent HCl decidedly increased the diastatic action of saliva, but while the observation was correct the result was wrongfully attributed to 0·005 per cent free acid when it should have been attributed to the same percentage of combined acid, where doubtless the proteid matter was not wholly saturated. Likewise Watson's‡ oft-quoted result, where the addition of a drop of strong acid to saliva gave him an increased diastatic action, was doubtless due to the acid-proteid matter formed, and not to free acid, though it may have been due to partial or complete neutralisation.

We endeavoured to ascertain whether the acid-proteid matter formed by the addition of acid to undiluted saliva would have any destructive action on the diastatic ferment when warmed at 40° C. Of course only a slight action, if any, could be expected, still it seemed of sufficient importance to warrant the experiment. Accordingly two mixtures were prepared as follows:—

	A.	B.
Saliva	20·0 c.c.	20·0 c.c.
HCl 0·2 p.c. to neutralise	6·8	6·8
HCl 0·2 p.c. to combine with proteids	—	3·2
H_2O	13·2	10·0
	40·0	40·0
	Neutral.	0·016 „ HCl combined.

These two solutions were warmed at 40° C. for one hour, then neutralising and equalising‖ mixtures were added, after which starch and water to 100 c.c. The results were in A a conversion of 38·68 per cent of the starch into sugar, and in B a conversion of 38·26 per cent, so that, while there may have been some little destruction of the

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.

* *Centralbl. Med. Wiss.*, 1875, 15.
† Chittenden and Griswold, *Amer. Chem. Jour.*, vol. iii., 312.
‡ *Journ. Chem. Soc.*, 1879, 543.
‖ Equivalent amounts of standard acid and sodium carbonate solutions, so that A, for example, might contain the same amount of sodium chloride as B.

ferment, it is plain that the diminished action noticed in the two preceding cases, in the presence of the larger percentages of acid-proteid matter, was probably due to simple retardation, since the percentage of combined acid was not more than half that in the above experiment.

We have studied the influence of acid-proteid matter on salivary digestion still further by experimenting likewise with peptones; and in studying the influence of acid-peptones on the action of the ferment we have been impressed with the striking effect of very minute quantities of acid on the ordinary action of peptones, increasing it very decidedly. It has already been shown that the presence of 0·05, 0·1 and 0·2 per cent of neutral peptone produces, in neutral solutions, a like increased diastatic action; with 0·5 per cent peptone the increase is as much as with 0·2 per cent,—that is, in the case of saliva considerably diluted. With acid-peptones, however, the effect produced is quite different, and the amount of combined acid necessary to produce this different effect is quite small.

Peptones as usually prepared contain a small amount of combined acid. The sample we used required per grm. 0·014 grm. Na_2CO_3 to make it neutral: this would be equivalent to 0·00964 grm. HCl. Consequently the percentage of combined acid in the peptone, assuming it to be hydrochloric acid, would be 0·964 per cent. With such an acid-peptone the following experiments were tried:—

Series XVII.

20 c.c. saliva were neutralised and diluted to 100 c.c.; of this solution 10 c.c., equal to 2 c.c. of original saliva, were used in each digestion. Four experiments were tried, in three of which 0·050 grm., 0·100 grm., and 0·200 grm. of the above acid-peptone were added. Following are the results, after warming the mixtures at 40° C. for thirty minutes.

Per cent peptone.	Wt. Cu in one-eighth.	Total amount sugar formed.	Starch converted.
0	0·0766 grm.	0·3128 grm.	28·16 p.c.
0·05	0·0873	0·3560	32·05
0·10	0·0897	0·3656	32·91
0·20	0·0929	0·3784	34·21

Comparing these results with those obtained by similar percentages of neutral peptone the difference is sufficiently striking, and yet the percentage of combined acid in the digestive mixture, where there is present 0·20 grm. of acid-peptone, is but 0·0019 per cent calculated as HCl.

Experimenting with peptones completely saturated with acid, and in this case with what was known to be hydrochloric acid, results similar to the above were obtained, with, however, several suggestive deviations. The following series of experiments will serve to illustrate the main points of interest:—

Series XVIII.

40 c.c. filtered saliva were neutralised and diluted to 200 c.c.; 10 c.c. of this diluted fluid were used in each experiment.

A standard solution of peptone saturated with hydrochloric acid was also prepared.

The following percentages of peptone and combined acid were contained in the different digestive mixtures of 100 c.c.

	Peptone. Per cent.	Combined HCl. Per cent.
1.	0	0
2.	0	0·0006*
3.	0·01	0·00057
4.	0·020	0·00115
5.	0·040	0·0023
6.	0·060	0·00345
7.	0·080	0·0046

* To saturate the proteids naturally present in the saliva.

Following are the results of the digestions:—

	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
No. 1	0·0872 grm.	0·3560 grm.	31·85 p.c.
2	0·0896	0·3656	32·91
3	0·0901	0·3672	33·06
4	0·0935	0·3808	34·28
5	0·0892	0·3640	32·77
6	0·0775	0·3160	28·45
7	0·0495	0·2048	18·43

It is to be noticed, first, that in this series of experiments the peptones, being completely saturated with acid, are present in much smaller percentages proportionally than the combined acid is, and the effect produced is a diminished diastatic action in the case of Nos. 6 and 7, in the presence of an amount of combined acid which, in the case of the proteids naturally present in saliva, has no retarding action whatever, but on the contrary a stimulating action. The addition of a larger amount of peptone to Nos. 5, 6, and 7, for example, the percentage of acid remaining the same, tends to bring up the diastatic action very decidedly.

It would appear from these results, moreover, assuming that the combining power of peptone is the same as the proteids present in saliva, that the presence of say 0·003 per cent combined HCl in the form of saturated acid-peptone has a retarding action, while the same percentage of combined HCl in the form of saturated salivary proteids has, in the case of saliva of the same dilution, a decided stimulating action. At the same time it is to be remembered that when acid is added to saliva some considerable acid may be used by the inorganic salts with formation of acid phosphates, for example. These results, moreover, indicate that such is doubtless the case. Increasing the percentage of peptone to say 1 per cent admits of the addition of larger amounts of hydrochloric acid without particularly retarding the action of the ferment; thus, as Langley and Eves state, "0·0075 per cent hydrochloric acid may be added to saliva diluted 10 or 20 times, provided 1 per cent peptone be present, and yet its action on starch be about equal to that of the saliva without peptone or acid."

Again it would appear that small percentages of acid-proteid matter, either peptones or the albuminous bodies present in saliva, tend to increase the diastatic action not only beyond the natural action of the saliva, but also somewhat beyond the action of the saliva plus the same percentage of neutral peptone. Thus, while the presence of a few hundredths of 1 per cent of neutral peptone in saliva diluted 1:50 caused about 1·5 per cent increased conversion of starch, acid peptone cause in thirty minutes 2·17 per cent increased conversion. Again, as has been seen, the acid-proteids of saliva cause a like increase. Large percentages of acid proteids, however, in which the albuminous matter is completely saturated, distinctly retard the diastatic action.

These results harmonise in a general way with the previous results obtained by one of us,* in which it was found that the presence of 1 per cent peptone in an acid-reacting fluid, which by itself almost completely stopped the diastatic action of the saliva, increased the diastatic action of the ferment above the action of the neutral saliva and also above the action of the neutral saliva plus the 1 per cent of neutral peptone.

We next endeavoured to ascertain how much of the retarding action of the acid-peptone is due to destruction of the ferment. Without giving details we have found that with saliva ten times diluted there is a noticeable destruction of the ferment in the presence of 0·028 per cent of combined acid, although it is not great. In this case it is to be understood that the amount of peptone present is only such as would furnish this percentage of combined acid. The following percentages of starch converted

* Chittenden and Ely, *loc. cit.*

(after neutralisation and equalisation) show the amount of destruction under the different conditions.

SERIES XIX.

Length of time at 40° C.	Per cent combined HCl.	Per cent peptone.	Starch converted.
	0	0	31·65 p.c.
30 min.	0·014	0·25	31·18
30	0·028	0·50	30·82
60	0·028	0·50	29·74
30	0·057	1·00	27·73

It is thus manifest from our results that the retarding influence of the larger percentages of acid-peptones is out of all proportion to their power of destruction. Still larger percentages of acid-saturated peptones produce a much greater destruction. Thus, by warming 10 c.c. of a neutral dilute saliva (1 : 5) with a solution of peptone saturated with acid, in such proportion that the mixture contained 0·430 per cent combined HCl, there was in thirty minutes an almost complete destruction of the ferment.

(To be continued.)

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 150.)

Results of Method.

A MIXTURE containing 24·83 per cent potassium sulphate gave, by method 1, 24·52 per cent K_2SO_4; by method 2, 25·51 per cent K_2SO_4; by method 3, 24·58 per cent K_2SO_4.

It appears that treatment with oxalic acid tends to give somewhat higher results than are otherwise obtained, and this opinion is corroborated by some of the data to follow.

The use of oxalic acid to convert nitrates into carbonates was also suggested by Mr. Clifford Richardson.†

Nitrates are, after conversion into carbonates, readily obtained in the form of chlorides. It is doubtful whether a single evaporation with hydrochloric acid is sufficient to convert all nitrates present into chlorides.

G. Krause‡ gives the method in use a decade ago at Strassfurt for estimating potash. It is not greatly different from that described by Stohmann. The salt, after solution, is treated with the slightest excess of barium chloride, made up to a standard volume, and an aliquot part of the filtrate taken for the estimation. This is evaporated to dryness in a porcelain dish after treatment with an excess of platinic chloride. The residue is moistened with a few drops of water and then treated with 2 to 3 c.c. alcohol of 90 to 95 per cent, and well rubbed with a glass rod. It is then washed by decantation, and, after having been dried at 120° to 130°, weighed on a tared filter.

Since the potash of commercial fertilisers is derived almost exclusively from kainite the fact that precipitated barium sulphate constantly incorporates the portion of the potassium chloride formed must not be lost sight of. It is true this loss is trifling, but at least its existence should be recognised.

West‖ has studied the disturbing effect of this substance and recommends the use of a factor for correction of results of a magnitude depending on the amount of sulphuric acid present. This is previously determined by titration with barium chloride and potassium chromate.

Ulex§ recommends the use of a 20 per cent glycerin solution in connection with the platinic chloride solution. For a mixture containing 0·5 grm. potassium chloride he uses 5 c.c. of the glycerin solution and 10 c.c. platinic chloride sp. gr. 1·1. On evaporation the glycerin is left as a syrup, the crystals of the double salt are more perfectly formed, and much less alcohol is required for washing.

In 1880 Mr. R. R. Tatlock issued a circular in which he proposed to estimate potash in its salts as follows :—

Take 35 grms. of the sample, dissolve in water, filter, and make up to 500 c.c. Place 10 c.c. of this solution in a small porcelain dish, add 20 c.c. water and then 30 c.c. of the platinic chloride solution containing 7 grms. platinum in 100 c.c. Evaporate on water-bath, but not to complete dryness, add a few drops of water, evaporate a second time, and treat the precipitate with 2 c.c. of the platinic chloride solution, stirring well. Bring the precipitate on a filter and wash it with 1 c.c. platinic chloride solution, and then wash dish, precipitate, and filter with as little 95 per cent alcohol as possible Dry the filter on the water-bath, transfer the precipitate as completely as possible to a small platinum dish, dry at 100°, and weigh. Incinerate the filter, which still contains traces of the precipitate, weigh the residue consisting of platinum and potassium chloride, calculate as K_2PtCl_6, and add to weight of salt found in platinum dish.

Zuchschwerdt* and West compared the results obtained by this method with those given by the method of Fresenius and a modified method of their own. Two determinations by the method of Fresenius gave 100·013 and 100·005 per cent, respectively. A mean of thirteen determinations of the same salt (chemically pure KCl), by Tatlock's method, gave 99·683 per cent. Nine determinations of the same by the author's modified method gave 100·023 per cent.

The radical defect of Tatlock's method is found in the solubility of potassio-platinic chloride in solutions of platinic chloride. In any case the method could only be used successfully in the absence of other acids than hydrochloric.

Following is an outline of the method employed by Zuchschwerdt and West :—

Dissolve 10 grms. of the sample in 500 c.c. of water, filter and take 20 c.c. of the filtrate Add to this in a porcelain dish 7 c.c. solution of platinic chloride (7 grms. platinum in 100 c.c.). Evaporate to consistence of syrup with frequent stirring. By this means free hydrochloric acid is mostly driven off. After cooling add 10 c.c. 95 per cent, alcohol, wash with alcohol, on to a tared filter, dry at 110° to 115°, and weigh.

David Lindo† has made an extensive study of the estimation of potash as platinum double salt. When only sodium and potassium chlorides are present, he recommends the following method :—

The sample dissolved in water should not contain more than 1 per cent of the two salts. To this a solution of platinic chloride is added, containing by weight twice as much platinum as there are sodium and potassium chlorides present. Evaporate to dryness on water-bath and dry for two or three minutes. Cool and treat residue with 20 c.c., 98 per cent, alcohol, filter by upward filtration, and wash three or four times with small quantities of alcohol of the same strength as above. Rub the precipitate to impalpable particles in a little alcohol. Decant the alcohol, bring the precipitate on a tared filter, wash two or three times with alcohol, dry at 130° and weigh. In nineteen experiments with mixed chlorides, in which the sodium chloride varied from 20 to 30 per cent of the potassium, the mean of the potassium chloride obtained was 100·04 per cent. According to Lindo, K_2PtCl_6 is difficultly soluble in a half saturated solution of ammonium chloride. In the presence of sulphates, Lindo proposes to use a solution of ammonium chloride, previously saturated with platinic chloride. He experimented on a mixture of 65 parts potassium chloride, 25 parts magnesium sulphate, and 10 parts sodium chloride.

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

† *Am. Chem. Jour.*, vol. iii., p. 422.

‡ *Arch. Pharm.*, ii., 407, 1874, and *Zeit. Anal. Chem.*, xiv., 184.

‖ *Zeit. Anal. Chem.*, 1881, pp. 357 *et seq.*

§ *Ibid.*, xvii., 275.

* *Zeit. Anal. Chem.*, 1881, pp. 185 *et seq*

† CHEMICAL NEWS, xliv., pp. 77, 86, 97, 129.

As a mean of ten experiments he found that he had recovered 99·99 of the potassium. For full details of the work I refer to the original papers, which are too long for further quotation.

Dreyfus* has proposed another modification for the estimation of potash. Ten grms. of the sample are incinerated after treatment with strong sulphuric acid. The ash is exhausted with hot water, the filtrate made up to 500, and 50 c.c. used for the potash determination by treatment with barium hydrate, filtration, and estimation with platinic chloride in the usual way.

An examination of the indirect methods of alkali estimation and of the disturbing influence of large quantities of sodium chloride on the direct estimation of potash as K_2PtCl_6 has been made by Dr. M. Kretschy.†

Interesting experiments in the estimation of potash in fertilisers may also be found in the report on the methods employed in the estimation of potash and phosphoric acid in commercial products prepared by Mr. A. H. Allen.‡

Dr. R. Fresenius‖ discusses the factor which should be employed for converting K_2PtCl_6 into KCl. He concludes, after carefully examining the results obtained by the several proposed factors, that 100 parts of K_2PtKCl_6 dried to a constant weight at 130° contain 30·56 parts of KCl.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 18th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Messrs. A. Dresel, Albert Ivatt, and Edward Willmore were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Cosmo Innes Burton, 11, Upper Phillimore Gardens, W.; Arthur William Clayden, North Lodge, Bath College, Bath; Christopher Hodgson, 144, Blake Street, Barrow-in-Furness; John William King, St. George's Hospital, W.; Henry Oliver Minty, 731, Wandsworth Road, S.W.; Richard Lloydd Whiteley, University College, Nottingham.

The following papers were read:—

30. "*Note on the Combustion of Cyanogen.*" By Harold B. Dixon, M.A.

A few years ago, on discovering that a spark might be sent through a well-dried mixture of carbonic oxide and oxygen without causing explosion, the author made several experiments on well-dried cyanogen and oxygen. These experiments seemed to show that cyanogen, like carbonic oxide, would not explode when dry. On returning to this investigation last autumn, the author discovered that the non-explosion of cyanogen previously observed was due not to the absence of moisture, but to the insufficient temperature of the spark. A spark 1 m.m. long from a Voss machine may be passed through a mixture of cyanogen and oxygen without causing explosion or any appreciable decomposition of the cyanogen. A mixture of the gases dried by standing in contact with anhydrous phosphoric oxide for two months exploded with violence when a strong spark was passed through it. A similar mixture which had stood in contact with a stick of potash also exploded violently.

It was found that the initial rate of explosion of carbonic oxide and oxygen increased rapidly with the amount of aqueous vapour present in the mixture: similar experiments made with cyanogen and oxygen showed that the initial rate of explosion diminished on adding aqueous vapour. It seems evident, therefore, that the explosion of cyanogen and oxygen does not depend upon the presence of water, which merely acts as a diluent in the mixture.

The author has shown that when a platinum wire is raised to redness in a well-dried mixture of carbonic oxide and oxygen, the wire glows intensely for a short time, and that complete combination takes place between the carbonic oxide and oxygen without visible flame. A precisely similar phenomenon is observed when a platinum wire is raised to full redness in cyanogen and oxygen: the wire glows brightly, and the cyanogen is oxidised to carbon dioxide. The tube is filled with orange vapour both when the oxygen is present in excess and in defect, but to a smaller extent in the latter case. No flame is visible round the glowing coil of wire. When the wire is only raised to dull redness no action seems to take place; on breaking the circuit the wire cools immediately, but when once the action has begun the wire continues glowing half a minute after the circuit is broken.

Discussion.

The President remarked that it appeared to him that the cause of this remarkable behaviour of cyanogen just brought under the notice of the Society depended probably not so much on the greater heat effect of the larger—or rather the longer—spark as on its greater potential energy, which starts the explosive wave, for it is generally supposed that the degree of temperature in a small spark is much the same as that of a larger one of the same electromotive force.

Dr. Armstrong said that the study of the behaviour of mixtures of cyanogen and oxygen, in comparison with that of mixtures of carbonic oxide and oxygen, was of peculiar interest, as cyanogen was one of the few gases which decomposed with evolution of heat. It was well known that a certain minimum electromotive force was required to electrolyse liquids, and to effect the electrolysis of gases a minimum—relatively very high—electromotive force was doubtless also required: an explanation of Mr. Dixon's observations might perhaps be based upon this circumstance.

31. "*On the Constitution of the Naphthalene-Derivatives.*" By R. Meldola.

Having been unable to attend the meeting of the Society when Mr. Stallard read his paper on the bromophthalic acids published in the current number of the *Journal* (p. 187), I may take this opportunity of pointing out that the new proofs advanced by him in favour of the constitution $CO_2H : CO_2H : Br = 1 : 2 : 3$ for the bromophthalic acid of m. p. 174° to 176° appear to me to be perfectly conclusive. The same conclusion has, in fact, been simultaneously arrived at by Guareschi (*Atti d. R. Accad. d. Sci. d. Torino*, vol. xxi., January 24th, 1886), who has obtained a chlorophthalic acid of m. p. 124° (anhydride, m. p. 124° to 125·5°) by the oxidation of γ-dichlornaphthalene. The constitution of this chlrophthalic acid is analogous to that of the bromophthalic acid obtained by Smith, Guareschi, and myself, and the isomeric acid of Alèn, which has the constitution—

$$CO_2H : CO_2H : Cl = 1 : 2 : 4,$$

and melts at a lower temperature (148° according to Alèn, 130° to 134° according to Krüger).

In accordance with this evidence it becomes necessary to modify the formula of Guareschi's nitrobromonaphthalene (m. p. 122·5°) as proposed by Mr. Stallard, and as the discoverer has himself pointed out in the paper referred to. The formula given by me in my last paper (*Trans.* 1885, 513) for the dibromonaphthylamine of m. p. 105° must also be corrected, and I may here point out that the constitution of this substance and of its derived di- and tri-bromonaphthalenes can be now definitely established. The corrected formulæ will be—

* *Bul. Soc. Chem.*, 38, p. 162.
† *Zeit. Anal. Chem.*, 15, pp. 37 *et seq.*
‡ Chemical News, vol. xxxv., Nos. 917 and 918, and vol. xxxvi., Nos. 920, 922, and 923.
‖ *Zeit. Anal. Chem.*, 1882, pp. 234 *et seq.*

Dibromonaphthylamine, m. p. 105°, Br : Br : NH_2 = = 1′ : 1 : 3
Dibromonaphthalene, m. p. 74°, Br : Br = 1 : 1′
Tribromonaphthalene, m. p. 110°, Br : Br : Br = 1 : 1′ : 3.

The alternative formula Br : Br : NH_2 = 1′ : 4 : 2 for the dibromonaphthylamine is excluded, because it does not give γ-dibromonaphthalene on displacing the NH_2 group by H.

The dibromonaphthylamine of m. p. 101° to 102° (*Trans.*, 1885, 514) must accordingly have the constitution—

$$NH_2 : Br : Br = 1 : 3 : 3' \text{ or } 1 : 3 : 2',$$

but there is at present no evidence to decide which of these formulæ is correct. That the second Br. atom does not occupy an α-position in the unsubstituted nucleus appears from the fact that I failed to obtain the 1 : 2 : 3 bromophthalic acid from it by oxidation. Further, as this dibromonaphthylamine gave only a slight trace of phthalic acid when oxidised, it would appear that the second Br atom does not enter the substituted nucleus. Unfortunately I have not enough of the dibromonaphthylamine left to repeat the oxidation experiment, but I find on reference to my laboratory notes that the oxidation was twice performed with different preparations, and with the same result in each case. The minute quantity of phthalic acid formed certainly does not appear to me sufficient to establish the formula Br : Br : NH_2 = 3 : 2 : 1, which is the only other one admissible (*Trans.*, 1885, 514).

The chief discrepancy at present remaining to be cleared up is the apparent identity of the two dibromonaphthalenes of m. p. 74°. I have re-examined the specimens in my possession, and, as far as melting-point and crystalline form can be trusted as indications of identity, these two dibromonaphthalenes are certainly indistinguishable from one another; nevertheless they may be isomeric, as I have already pointed out (*Trans.*, 1885, p. 516) that naphthalene derivatives which are known to be isomeric may have the same crystalline form and melting-point. The question can only be decided by a further study of the derivatives of the dibromonaphthalenes in question, but I regret that the quantity at my disposal is much too small to enable me at present to extend the research in this direction. The bromophthalic acid used by H. v. Pechmann (*Ber.*, xii., 2126) may have been the meta-compound, the production of erythroxyanthraquinone from the corresponding bromobenzoylbenzoic acid being due to intra-molecular migration to the ortho-position on fusion with alkali.

I may take the present opportunity of pointing out that the dibromonaphthalene (m. p. 68°) obtained by Canzoneri (*Gazzetta*, xii., 424) from Smith's monobromo-β-naphthol, is in all probability identical with the orthodibromonaphthalene described in a former paper (*Trans.*, 1883, 5). It has been argued that the investigations of Beilstein and Kurbatow (*Annalen*, ccii., 228) show that β-dinitronaphthalene (m. p. 176°) has both NO_2 groups in the same benzene-ring, most probably in the meta-position (Jacobson, *Inaug. Diss.*, 1882, 37). If so, ζ-dichloronaphthalene (m. p. 83°), obtained by Atterberg (*Ber.*, ix., 1730) by the action of PCl_5 upon this dinitronaphthalene, is analogous to the metadibromonaphthalene (m. p. 64°) described by me in 1879 (*Ber.*, xii., 1962).

Discussion.

Dr. ARMSTRONG said that as regards the constitution of β-dinitronaphthalene, the production from it of *dinitrophthalic acid* (Beilstein and Kurbatow), by the action of nitric acid in sealed tubes, was not satisfactory evidence; and Jacobson's contention that Liebermann and Dittler's nitro-α-naphthol (m. p. 128°) could not well be an ortho-derivative because the amidonaphthol prepared from it did not furnish a quinone on oxidation, was equally unsatisfactory as being negative evidence; there was no obvious flaw in Atterberg's argument that ζ-dichloronaphthalene is an α-α-derivative ("Watts's Dictionary," vol. viii., Pt. II., p. 1376). The argument from analogy is apt to break down on comparing benzene with naphthalene, as two new "laws" come into force in the case of naphthalene, namely, the tendency for substitution to take place in both "rings," and the marked tendency to form α-derivatives. The formula given by Prof. Meldola to the dibromonaphthylamine melting at 101° to 102° must be accepted with reserve on this latter account.

32. "*Action of Ammonia on Chromyl Dichloride.*" By SAMUEL RIDEAL, B.Sc.

Dry ammonia gives with chromyl dichloride ammonium chloride, nitrogen, and brown oxide of chromium, the reaction being expressed by the equation—

$$3CrO_2Cl_2 + 8NH_3 = 6NH_4Cl + N_2 + Cr_2O_3 \cdot CrO_3.$$

No addition products or chromammonium bases are formed when the vapour of chromyl dichloride burns in an atmosphere of dry ammonia under the ordinary temperature and pressure. This explanation of the reaction agrees with the observation of Persoz, that 20·98 parts of chromyl dichloride absorb 79·1 parts of ammonia.

33. "*Note on the Estimation of Resin in Soaps.*" By C. R. ALDER WRIGHT, D.Sc., F.R.S., and C. THOMPSON, F.C.S.

We have had occasion to make a number of experiments with various of the methods hitherto proposed for the determination of resin in soaps, with the general result of finding that one and all leave much to be desired in the way of accuracy. Sutherland's process (oxidation by nitric acid) in some instances gave fair results; but this occurs mostly through the balancing of two opposite sources of error, viz., incomplete removal of resin by oxidation, tending to *increase* the percentage of fatty acid found, and oxidation of true fatty acids, tending to *decrease* it. Treatment of aqueous soap solution by various processes intended to throw out of solution true soaps of fatty acids leaving dissolved resinates did not answer at all well in our hands: sometimes fatty soaps were retained in solution, and resinates were often mechanically carried out of solution along with the fatty soaps, and no certainty of complete separation was ever attainable.

On the whole the process recommended by Gladding (CHEMICAL NEWS, April 14, 1882) seemed to give figures most in accordance with the truth, provided the nature of the fatty matters contained in the soap examined were approximately known so as to permit of the application of a correction-factor variable to some extent with this nature. The method consists in separating the fat acids, dissolving about 0·5 grm. in 95 per cent alcohol, neutralising with saturated alcoholic potash, then addding a few additional drops and boiling to saponify any small quantity of glyceride present (through imperfection in manufacture, &c.); after cooling, ether is added to 100 c.c., and finely powdered *neutral* silver nitrate, and the whole well agitated; finally a known fraction of the ethereal solution of silver resinate, &c., is treated with hydrochloric acid, and the liberated resin, &c., weighed after evaporation of the ether. According to Gladding (who, however, only quotes a very small number of test experiments) 100 c.c. of alcoholic ether dissolves 23·5 m.grms. of oleic acid, when "pure fat acid" (mixture of stearic and oleic ?) is thus treated; and this correction-factor he found to be applicable with accuracy when Castille soap, linseed-oil soap, and soaps containing known amounts of resin were examined.

Our experience, however, is that 23·5 m.grms. (representing 4·7 per cent on 0·5 grm. fatty acids and resin) is a correction-factor by no means universally applicable. With pure stearic or oleic acid it is much too large; with acids from castor-oil far too small; with various mixtures it is not far from the truth. Thus the values given in the Table were obtained as the result of a large number of observations which, moreover, did not always show a high degree of concordance, notwithstanding all the care taken to avoid sources of error; partly no doubt this is due to the circumstance that different specimens of oils, &c., were employed in the production of the soaps treated.

The temperature was throughout not far from 18° C., but was not kept absolutely uniform, which circumstance may again partly account for apparent irregularity in the solubility of the silver salts.

Although Gladding's correction of 23·5 m.grms is not strictly applicable in all cases, yet the figures in the Table indicate that it is not far from the truth in at least a number of instances of mixtures likely to occur in actual manufacture: in such cases a tolerably fair approximation to the truth is attainable by assuming that the weight of the resin apparently found in 0·5 grm. of fatty acids should be diminished by some 25 m.grms., or, what is the same thing, that the percentage of resin found in the total fatty acids, &c., is 5 per cent too high. But this correction cannot be regarded as applicable universally.

Nature of fatty matters in soap examined.	Fatty matters dissolved (as silver salt) in 100 c.c. of alcoholic ether. Maximum. M.grms.	Minimum. M grms.	General average. M grms.
Pure stearic acid..	16·0	8·0	11·6
Pure oleic acid	15·0	9·0	12·0
Nearly pure palmitic acid..	30·0	28·0	29·1
Cotton-seed oil	34·0	20·0	26·9
Castor oil	62·0	49·0	53·9
Cocoanut oil (fatty acids dried on water-bath) ..	17·5	12·0	14·8
Cocoanut oil (fatty acids dried over H_2SO_4	23·0	19·0	21·1
Stearic and oleic acids, in nearly equal proportions	22·0	18·0	19·1
Stearic acid and cotton-seed oil, in nearly equal proportions	—	—	25·5
Oleic acid and cotton-seed oil, in nearly equal proportions	—	—	24·5
Stearic acid and cocoanut oil (water-bath), in nearly equal proportions	—	—	23·4
Oleic acid and cocoanut oil (water-bath), in nearly equal proportions	—	—	25·6

A source of error that should not be overlooked is that the concentrated alcoholic potash used as directed by Gladding is liable on keeping to become dark-coloured, and in so doing to contain more or less notable amounts of resinoid matter (from action on the alcohol or impurities contained therein. Several milligrammes of increment in the ether residue may readily be brought about by the use of such potash solution. Another source of error is the decomposition of certain of the insoluble silver salts of fatty acids by light, causing in some instances appreciable amounts of additional matter to become dissolved in the alcoholic ether.

34. "*The Properties of the Nitrobenzalmalonic Acids.*" By Charles M. Stuart, M.A.

On boiling benzalmalonic acid, $C_6H_5{\cdot}CH : C(COOH)_2$, with water, it is resolved partly into benzaldehyde and malonic acid (1), and partly into cinnamic acid and carbon dioxide (2); the three nitro-derivatives behave similarly. the percentage amounts converted in accordance with the first and second modes of change being shown in the accompanying Table (see next column).

Benzalmalonic acid and its para- and meta-nitro-derivatives form additive compounds with bromine and with hydrogen bromide, which are decomposed by water. The ortho-nitro-derivative is converted both by the action of bromine and hydrogen bromide into a condensation product which is not decomposed by water or alcohol. The author suggests that this behaviour may be regarded as an argument in favour of Kekulé's benzene formula.

From cinnamic acid and malonic acid he has obtained a phenyl-butindicarboxylic acid,—

$$C_6H_5{\cdot}CH : CH{\cdot}CH : C(CO_2H)_2;$$

	Boiled for 1 hour. I.	II.	Total.	Boiled for 15 min. I.	II.	Total.
Benzalmalonic acid—						
	85·2	—	—	57·8	1·41	59·2
	85·8	10·8	96·6	58·3	1·25	59·5
	84·4	10·6	95·0	—	—	—
Paranitrobenzalmalonic acid—						
	80·2	14·8	95·0	61·54	3·89	65·4
	82·7	12·4	95·1	62·64	3·77	66·4
Metanitrobenzalmalonic acid—						
	83·1	10·4	93·5	61·3	6·3	67·6
	79·9	14·4	94·3	62·5	5·8	68·3
	79·7	12·6	92·3	—	—	—
Orthonitrobenzalmalonic acid—						
	24·5	5·7	30·2	8·7	1·18	9·88
	23·6	6·5	30·1	8·71	1·25	9·96
	24·4	6·4	30·8	—	—	—

this melts at 208°, but is resolved into CO_2 and cinnamenylacrylic acid.

Salicylic and malonic acids give coumarincarboxylic acid; this melts at 187° without decomposing, but is resolved at a higher temperature into CO_2 and coumarin.

Anniversary Meeting, March 30th, 1886.

The following Officers and Council were elected:—

President—H. Müller, Ph.D., F.R.S.

Vice-Presidents who have filled the Office of President—Sir F. A. Abel, C.B., D.C.L., F.R.S.; Warren De la Rue, D.C.L., F.R.S.; E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Sir Lyon Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

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NOTICES OF BOOKS.

An Introduction to the Study of Chemistry. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. New York: Henry Holt and Co.

This work, which decidedly belongs to the superior grade of chemical manuals, is one of the "American Science Series, Briefer Course." In his Preface the author makes some very important remarks on the educational value of chemical study. He holds that in teaching chemistry two mistakes are commonly made. "The first is that of considering the profoundest theories of the science before the student is prepared for them. Hence they make little impression upon his mind, and he only learns *to repeat words about them* without having any real comprehension of them."

We beg to call especial attention to the words which we have italicised. The view is fast gaining ground that not merely in chemistry, but in all departments of the physical and natural sciences, the student should begin not with books, but with the phenomena themselves. When the facts in question have been witnessed and duly

observed,—there is a difference between witnessing and observing,—then, and only then, the words in which such phenomena can be described become clearly and fully intelligible. Text-books are then of use for co-ordinating what has been observed. The student who has read much about chemistry before seeing chemical phenomena seems bewildered when he enters the laboratory. He is not unlikely to ask the teacher "But what am I to observe?" Verbalism seems to have entered into his inmost being.

Prof. R. Galloway pointed out in one of his works the significant fact that in grammar-schools the junior forms seemed better able to observe and understand phenomena than their seniors. The exclusive attention paid to words and abstractions seems to beget in the mind the defect or the vice of inobservance.

"The other mistake," according to Prof. Remsen, "is that of giving directions for experiments without making it clear to the student why they are performed or what they teach. The result is that he sees little or no connection between the subjects treated in the text-book and the things which he works with in the laboratory."

"The first object of a course in science should be to develop a scientific habit of thought." Expanding this proposition of the author's, we may say that the educational object of the study of any science is to cultivate in the student the power of observation. He must learn to see every feature of the phenomena presented to him, and see all this correctly, not mixing up guesses with actual perceptions.

Slovenly, random experimentation is justly denounced as being of little value. Says the author:—"When teachers of chemistry acquire this feeling, and work in this spirit, the educational value of laboratory courses will be greater than it frequently is now. The average playing with test-tubes and precipitates is of questionable benefit. As it has been dignified by the undeserved name of scientific training, and put forward in place of the real thing, many thinking (?) men have been led to question the value of scientific training, and to adhere to the old drill in grammatical forms and mathematical problems."

We should be the last to defend slovenly, random experimentation. At the same time we think that the greatest error in teaching chemistry, in England at least, is one which Prof. Remsen overlooks. This error is to treat chemistry as something to be read about, committed to memory, and ultimately examined in. Says our author:—"A slovenly laboratory course in chemistry is a poor substitute for a well-conducted course in mathematics or languages." In fact the former does not profess to be a substitute for the latter. But neither is the best course in languages, nor even in mathematics, of any avail towards teaching the arts of observation, and of drawing right inductions from the facts observed.

The author has in this work selected for special consideration such substances and such phenomena as he considered best suited for giving an insight into the nature of chemical action.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 11, March 15, 1886.

Application of the Diagram of Colours to Experiments made on a Colour-blind Subject.—R. Ferret.—The author concludes that all the colours which a colour-blind eye confounds together have their representative points on one and the same right line parallel to a direction which is constant for this eye. He raises the questions: Is the direction of confusion absolutely the same for all colour-blind persons, making abstraction of the three classes of colour-blindness generally admitted? Is not, in certain persons less thoroughly colour-blind than Maxwell's subject, the direction of confusion not a direction for which the errors committed in the evaluation of the divergences existing between the different colours would pass through a maximum? Is not the infirmity of those rare cases mentioned as recognising among all colours merely the differences of light and shade not the result of two forms of colour-blindness relating to two different directions, so that the places of the colours confounded by these persons are planes mutually parallel.

New Apparatus for the Determination of Oxygenated Water.—Maurice de Thierry.—This apparatus cannot be intelligibly described without the accompanying figure.

Potassium and Sodium Selenides.—O. Fabre.—The author has obtained four sodium selenides, three of which contain respectively 16, 9, and 5 mols. of water, while the fourth is anhydrous. The potassium selenides are less stable; the author has here also obtained and examined three hydrates containing 19, 14, and 9 mols. of water and an anhydrous form. The method followed has been to pass gaseous hydroselenic acid into strong alkaline solutions. To obtain pure products it is necessary to operate in an atmosphere of nitrogen.

Formation and Dissociation of Barium and Strontium Manganates.—The decomposition of the alkaline-earthy manganates in an oxidising fire seems to traverse a cycle. At a dull red it is almost null; at the heat of a Bunsen burner it becomes very perceptible and the manganite formed corresponds to the type MnO_2RO. At a temperature between the melting-points of silver and copper the dissociation reaches a maximum corresponding to the formation of a dimanganite, $2MnO_2,RO$. At a stronger heat, between the melting-points of copper and gold, the manganite re-appears, whilst at a still higher temperature (1500° for the barium compound and 1600° for strontium) manganate is again produced.

Variations of Solubility of Certain Chlorides in Presence of Hydrochloric Acid.—R. Engel.—The author proposes the following approximate generalisation: the solubility of the chlorides which hydrochloric acid precipitates from their solutions in water diminishes in presence of this acid by a quantity corresponding sensibly to an equivalent of the chloride for each additional equivalent of hydrochloric acid.

Separation and Determination of Copper, Cadmium, Zinc, Nickel, &c.—Ad. Carnot.—This paper will be inserted in full.

Existence of the Elements of Milk-Sugar in Plants.—A. Müntz.—The author refers to the constitutional difference between milk-sugar and glucose. He finds that galactose, hitherto regarded as absent in plants, is chemically and physically identical with the arabinose of true gum arabic. Hence he considers that the latter name ought to be cancelled, and hence both the proximate elements of milk-sugar exist in abundance in the vegetable world.

Splitting up of the Sodium-Ammonium and Sodium-Potassium Racemates.—G. Wyrouboff.—A critique of M. Bichat's paper communicated to the Academy on Feb. 22nd. The writer concludes that the inorganic germs which M. Bichat supposes as intervening play no part other than that of desupersaturating solutions capable of becoming supersaturated; their action is null when supersaturation is excluded. In the case of the sodium potassium salt we may, according to the temperature, cause by the introduction of a crystal of the corresponding salt the crystallisation either of a racemate or a tartrate. The splitting up of the sodium-ammonium and

he sodium-potassium racemates is therefore a simple question of solubility, which itself is again a function of the temperature.

On the Earth Yα.—W. Crookes.—See CHEMICAL NEWS, vol. liii., p. 133.

On the Mosandra of Lawrence Smith.—Lecoq de Boisbaudran.—Dr. Marvin, of Louisville, has supplied the author with a specimen of an earth from the laboratory of the late L. Smith and considered as being impure mosandra. It contains much didymium and samarium; but L. Smith observed absorption spectra carefully and described the salts of mosandra as not giving any. It is therefore evident that the specimen obtained from Dr. Marvin was at the most mosandra very imperfectly purified. M. Lecoq de Boisbaudran fractionated this earth with ammonia as far as the small bulk of the specimen permitted; almost all the didymium and the greater part of the samarium were thus eliminated. The residue gave the electric spectrum of Yα very brilliantly, and the author therefore suspected that this latter body might perhaps represent the purified matter described by Smith. However, as M. de Marignac very judiciously pointed out, L. Smith described his mosandra as an oxide deeply tinged with an orange-yellow, whilst the Yα prepared by M. de Marignac is very faintly coloured and would probably be white if absolutely pure. The earth which M. de Boisbaudran has obtained from crude mosandra by eliminating didymium and samarium is of a deep orange yellow and gives the fluorescences $Z\beta$ and $Z\alpha$, the former predominating. Hence, and in accordance with the opinion of M. de Marignac, it appears very probable that the mosandra of L. Smith is essentially a mixture of Yα and of terbia, the latter probably in excess.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—The chemical laboratory of Geh. Hofrath Prof. Dr. A. Fresenius, at Wiesbaden, enjoys a very large attendance. In the winter term, 1885—86, there were 90 students on the books. Of these, 58 were from Germany, 6 from Austro-Hungary, 6 from North America, 5 from England, 5 from Russia, 3 from France, 2 from Switzerland, 2 from Holland, 1 from Luxemburg, 1 from Sweden, and 1 from Norway. Besides the director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect Brahm. The assistants in the instruction laboratory were two in number, in the private laboratory twelve, and in the Versuchsstation three. During the last term, besides the scientific researches, a great number of analyses were undertaken in the different departments of the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, agriculture, and hygiene.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Vulcanised India-rubber.—Can anyone inform me where I may obtain information as to the various substitutes for caoutchouc, and means of detection of same when vulcanised and mixed with various mineral substances, such as oxide of zinc, chalk, steatite, &c.? Also if there is any solvent known to dissolve vulcanised caoutchouc.—S. S.

Ear-rings of Lead.—Has lead any rapid chemical healing power, for in Russia the ears of ladies are pierced with rings of that metal? And will any of your readers kindly supply the reason why lead rings obtain such popularity in Russian fashionable society? Not being a chemist I am obliged to seek the kind assistance of your journal through the "Notes and Queries" column.—W. T.

MEETINGS FOR THE WEEK.

MONDAY, 5th.—Medical, 8.30.
—— Society of Chemical Industry, 8. "The Principles and Methods of Testing Cementing Materials," by Prof. Unwin, M.I.C.E.
—— Society of Arts, 8. (Cantor Lectures). "The Arts of Tapestry-Making and Embroidery," by Alan S. Cole.
TUESDAY, 6th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "The Function of Circulation," by Professor Arthur Gamgee, M.D., F.R.S.
—— Pathological, 8.30.
WEDNESDAY, 7th.—Society of Arts, 8. "Preparation of Drawings for Photographic Reproduction," by J. S. Hodson.
—— Geological, 8.
THURSDAY, 8th.—Royal, 4.30.
—— Royal Institution, 3. "Electro-Chemistry," by Prof. Dewar, F.R.S.
—— Society of Arts, 8. "Asbestos and its Applications," by James Boyd.
—— Mathematical, 8.
FRIDAY, 9th.—Royal Institution, 9. "New Applications of the Mechanical Properties of Cork to the Arts," by W. Anderson, M.Inst.C.E.
—— Quekett Club, 8.
—— Astronomical, 8.
SATURDAY, 10th.—Royal Institution, 3. "Fuel and Smoke," by Prof. O. Lodge, D.Sc.
—— Society of Arts, 3. "Electricity," by Professor George Forbes, M.A., F.R.S.E.
—— Physical, 3. "On the Causes of the Diurnal Changes of Terrestrial Magnetism," by Professor Balfour Stewart, F.R.S.

CHEMICAL LABORATORY,
WIESBADEN, GERMANY.

Director—Prof. R. FRESENIUS, Ph.D.

Practical Instruction in the Laboratory .. .. Prof. R. FRESENIUS, Ph.D. Prof. H. FRESENIUS, Ph.D. W. FRESENIUS, Ph.D.; E. HINTZ, Ph.D.

LECTURES.

Experimental Chemistry (Inorganic)	Prof. H. FRESENIUS, Ph.D.
Experimental Physics	W. FRESENIUS, Ph.D.
Stöchiometry	
Organic Chemistry	E. HINTZ, Ph.D.
Chemical Technology	
Microscopy, with exercises in Microscopic work	E. BORGMANN, Ph.D.
Chemistry and Analyses of Foods ..	Prof. H. FRESENIUS, Ph.D. E. BORGMANN, Ph.D. W. FRESENIUS, Ph.D. and E. HINTZ, Ph.D.
Hygiene	Dr. med. F. HUEPPE.
Practical exercises in Bacteriology ..	
Technical Drawing, with exercises ..	F. BRAHM.

The next Session commences on the 28th of April. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. KREIDEL'S Verlag, at Wiesbaden, or to the undersigned.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1376.

SUGGESTIONS AS TO THE CAUSE OF THE PERIODIC LAW, AND THE NATURE OF THE CHEMICAL ELEMENTS.*

By THOS. CARNELLEY, D.Sc.,
Professor of Chemistry in University College, Dundee.

(Continued from p. 159.)

Now what conclusions are to be drawn from such facts as those represented in the above tables? In addition to the general conclusion *that the melting- and boiling-points of both organic and inorganic compounds obey the same rules*, we may also infer—

That the elements as a whole are analogous to the hydrocarbon radicles (see Tables IX. and XI.), *having a similar function in their several compounds, and most probably a somewhat similar chemical constitution*, or, shortly, *they are analogous in both form and function.*

This analogy will be best exhibited in Tables VIII. and IX.

Taking first the points of *resemblance* :—

1. The properties of the elements and their compounds and those of the hydrocarbon radicles and their compounds are strictly periodic, a period in each case consisting (if we neglect group VIII.) of seven members.

2. As shown above the melting and boiling-points of both the halogen and alkyl compounds of either the elements of Table VIII. or of the hydrocarbon radicles in Table IX. follow the same rules; that is to say, if we make any systematic arrangement of the compounds of the Elements in Table VIII., and a corresponding systematic arrangement of the compounds of the radicles in Table IX., then the numerical order of the physical properties (as represented by the melting and boiling-points) will be the same in the two cases.

3. The atomicity in each series, in the case of both elements and hydrocarbon radicles, increases up to the middle group and then diminishes or increases up to the 7th or last group (*cf.* differences *infra*).

4. The compounds of the elements are strictly analogous in form to those of the hydrocarbon radicles, as witness the following examples :—(See next page.)

5. Mendeljeff in his original paper on the Periodic Law (*Annalen*, Suppl., viii., 133) draws attention to the fact that the elements of the first or Li-series, and also part of the Na-series, are to some extent different from those of the other series, and the elements comprising them are hence termed by him "typical elements." The exceptional character of these series he compares with the usual and well-known exceptional character of the

TABLE VIII.—*Natural Classification of the Elements.* (After Mendeljeff).

Groups	I.	II.	III.	IV.	V.	VI.	VII.	
Series.	Monads.	Dyads.	Triads.	Tetrads.	Triads or Pentads.	Dyads or Hexads.	Monads or Heptads.	Group VIII.
0.	H=1							
1.	Li=7	Be=9	B=11	C=12	N=14	O=16	F=19	
2.	Na=23	Mg=24	Al=27	Si=28	P=31	S=32	Cl=35·5	
3.	K=39	Ca=40	Sc=44	Ti=48	V=51	Cr=52	Mn=54	Fe=56, Co=59, Ni=59, (Cu=63).
4.	Cu=63	Zn=65	Ga=69	EkaSi=72 (?)	As=75	Se=79	Br=80	
5.	Rb=85	Sr=87	Yt=89	Zr=90	Nb=94	Mo=96	—	Ru=104, Rh=104, Pd=106 (Ag=108).
6.	Ag=108	Cd=112	In=113	Sn=118	Sb=120	Te=125	I=127	
7.	Cs=133	Ba=137	La=138	Ce=140	Di=142	Tb=149 (?)	—	—, —, —, (—).
8.	—	—	—	—	Er=166 (?)	—	—	
9.	—	—	Yb=173	—	Ta=182	W=184	—	Os=193, Ir=193, Pt=195, (Au=197).
10.	Au=197	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
11.	—	—	—	Th=234	—	U=240	—	—, —, —, (—).

TABLE IX.—*Classification of the Hydrocarbon Radicles.*

Groups	I.	II.	III.	IV.	V.	VI.	VII.	
Series.	Monads or Heptads.	Dyads or Hexads.	Triads or Pentads.	Tetrads.	Triads.	Dyads.	Monads.	
0.							H=1	
1.	—	—	—	CX_4	$(CH)X_3$	$(CH_2)X_2$	$(CH_3)X$	
2.	—	$(C_2)X_2$	$(C_2H)X_3$	$(C_2H_2)X_4$	$(C_2H_3)X_3$	$(C_2H_4)X_2$	$(C_2H_5)X$	X=any monad element or radical, *e.g.*, Cl, Br, I, CH_3, C_2H_5, &c.
3.	$(C_3H)X$	$(C_3H_2)X_2$	$(C_3H_3)X_3$	$(C_3H_4)X_4$	$(C_3H_5)X_3$	$(C_3H_6)X_2$	$(C_3H_7)X$	
4.	$(C_4H_3)X$	$(C_4H_4)X_2$	$(C_4H_5)X_3$	$(C_4H_6)X_4$	$(C_4H_7)X_3$	$(C_4H_8)X_2$	$(C_4H_9)X$	
5.	$(C_5H_5)X$	$(C_5H_6)X_2$	$(C_5H_7)X_3$	$(C_5H_8)X_4$	$(C_5H_9)X_3$	$(C_5H_{10})X_2$	$(C_5H_{11})X$	
6.	$(C_6H_7)X$	$(C_6H_8)X_2$	$(C_6H_9)X_3$	$(C_6H_{10})X_4$	$(C_6H_{11})X_3$	$(C_6H_{12})X_2$	$(C_6H_{13})X$	
&c.	&c.	&c.	&c.	&c.	&c.	&c.	&c.	

The hydrocarbon radicles in the table may be represented by the general formula $C_n H_{2n+(2-x)}$, in which n = the series, and $x=(8-a)$, a being the group to which the element belongs.

It will be seen at a glance that there is a great resemblance between the two tables both in structure and arrangement; but there are nevertheless certain points of difference which it will be well to mention in detail along with the points of resemblance.

first and second members of a homologous series of organic chemistry.*

* A Paper read before the British Association, Aberdeen Meeting.

* Compare Perkin's paper on "Magnetic Rotation" (*Jour. Chem. Soc. Trans.*, 1884, p. 552; Chem. News., xlix., 285), in which he says "that any body to be the first member of a homologous series must contain the CH_3-group, because it is by the introduction of additional members of this group that we form the series. Thus, propionic acid should be the first member of the homologous series of fatty acids. Formic and acetic acids do not contain the CH_3-group, and they are well known to possess properties which are not altogether comparable with those of the other fatty acids."

I.	II.	III.	IV.	V.	VI.	VII.
$Na(OH)$. Sodium hydrate.	$Mg(OH)_2$. Magnesium hydrate.	$Al(OH)_3$. Aluminium hydrate.	$Si(OH)_4$. Silicic acid.	$P(OH)_3$. Phosphorous acid.	$S(OH)_2$. Hyposulphurous acid.	$Cl(OH)$. Hypochlorous acid.
$C_3H(OH)$. ?	$C_3H_2(OH)_2$. ?	$C_3H_3(OH)_3$. Trioxymethylene.	$C_3H_4(OH)_4$. Propylphycite.	$C_3H_5(OH)_3$. Glycerol.	$C_3H_6(OH)_2$. Propylene glycol.	$C_3H_7(OH)$.* Propyl alcohol.
$NaCl$. Na chloride.	$MgCl_2$. Mg chloride.	$AlCl_3$. Al chloride.	$SiCl_4$. Si tetrachloride	PCl_3. P trichloride.	SCl_2. Sulphur dichloride.	$ClCl$. Chlorine chloride.
$(C_3H)Cl$. ?	$(C_3H_2)Cl_2$. Dichlorallylene.	$(C_3H_3)Cl_3$. Trichlorpropylene.	$(C_3H_4)Cl_4$. Tetrachlorpropane.	$(C_3H_5)Cl_3$. Trichlorpropane.	$(C_3H_6)Cl_2$. Dichlorpropane.	$(C_3H_7)Cl$.* Propyl chloride.
$NaCH_3$. ?	$Mg(CH_3)_2$. ?	$Al(CH_3)_3$. Al methide.	$Si(CH_3)_4$. Si methide.	$P(CH_3)_3$. Trimethylphosphine.	$S(CH_3)_2$. Methyl sulphide.	$Cl(CH_3)$. Methyl chloride.
$C_3H(CH_3)$. ?	$C_3H_2(CH_3)_2$. Valerylene.	$C_3H_3(CH_3)_3$. Hexylene.	$C_3H_4(CH_3)_4$. Heptane.	$C_3H_5(CH_3)_3$. Hexane.	$C_3H_6(CH_3)_2$. Pentane.	$C_3H_7(CH_3)$.* Butane.
Na_2O. Sodium oxide.	MgO. Mg oxide.	Al_2O_3. Al oxide.	SiO_2. Si dioxide.	P_2O_3. P trioxide.	$[SO]$. ?	Cl_2O. Cl monoxide.
$(C_3H)_2O$. ?	$(C_3H_2)O$. ?	$(C_3H_3)_2O_3$. ?	$(C_3H_4)O_2$. ?	$(C_3H_5)_2O_3$. Glyceric ether.	$(C_3H_6)O$. Propylene oxide.	$(C_3H_7)_2O$.* Propyl oxide.

* Most probably the series of hydrocarbon radicles, as represented here and in Table IX., should be inverted so that Groups VII., VI., and V. would become I., II., and III., respectively. With regard to this point, *vide infra*. If such an inverted arrangement be adopted, then glycerol, propylene glycol, and propyl alcohol would be represented as analogous to Al, Mg, and Na hydrates respectively, an analogy which would be truer than the one shown here.

This therefore furnishes another point of analogy between the elements of Table VIII. and the radicles of Table IX.

6. The numerous cases in which, in many reactions, the hydrocarbon radicles act in a manner strictly analogous to that of the elements are too well known to need further particularisation in detail.

Let us now consider the points in which the elements of Table VIII. differ from the radicles of Table IX.

1. Though it is true that both the elements and the hydrocarbon radicles are strictly periodic in their properties and in those of their compounds, and that the periods are of the same length, consisting of seven members in each case, yet the nature of the periodicity (at least in so far as the melting- and boiling-points are concerned) is not exactly the same in both. In the case of the halides of the elements the melting- and boiling-points *diminish as we pass from the first to the seventh group*, whereas in the case of both the halides and alkides of the hydrocarbon radicles these properties *increase up to the fourth group, and then diminish to the seventh*; whilst the alkides of the elements partake of the features of each, since they increase up to the third and then diminish to the seventh group. The alteration in the order of size of these physical properties is therefore the same in all cases from the fourth to the seventh group inclusive, but different from the first to the third group. This difference and resemblance is shown in the following Table, in which the numbers referring to the halides have been obtained by adding the boiling-points (or melting-points) of the chlorides of the corresponding members of each series together, the same operation being repeated with the bromides and iodides. The sum of the boiling-points (or melting-points) of the chlorides is then added to that of the bromides and iodides, and the mean taken. A similar operation gives the average mean boiling-points for the alkides (methides, ethides, propides). As there are five series under consideration, each number is the mean of $5 \times 3 = 15$ separate data: whilst in the case of the halides of the elements each number is the mean of 18 data, since in this case we are dealing with six series.

The above facts are rendered still more evident by Diagrams I., II., and III., of which I. shows the *average mean* curves of (1) the melting-points of the halides (Cl, Br, and I) of the elements; (2) the boiling-points of the alkides (Me, Et, Pr) of the elements; (3) the boiling-points of the halides (Cl, Br, I) of the hydrocarbon radicles; (4) the boiling-points of the alkides (methides only) of the same. The curve is constructed by taking the average mean temperatures of melting or boiling (see Table X.) as ordinates, and the atomicity of the elements or hydrocarbon radicles as abscissæ.

Diagrams II. and III. represent the same facts, but in greater detail. Diagram II. gives the *mean* curves of—(1) the alkides (Me, Et, Pr) of the elements*; (2) the halides (Cl, Br, I) of the hydrocarbon radicles; (3) the

* That is, of elements of Series 1, 2. 4, 6, and 10, these being the only elements which combine with alcohol radicles.

TABLE X.

	Elements.		Hydrocarbon Radicles.	
	Halides. (Cl, Br, I).	*Alkides.* (Me, Et, Pr^a).	*Halides.* (Cl, Br, I).	*Alkides.* (Methides only) †
	Melting-points.*	Boiling-points.	Boiling-points.	Boiling-points.
Monads	870	—	—	289
Dyads	847	409	425	311
Triads	341	461	478	333
Tetrads	326	411	530	350
Triads	318	404	482	325
Dyads	303	366	415	301
Monads	277	312	338	264

* Data not sufficiently complete for boiling-points.

† Data not sufficiently complete for ethides and propides.

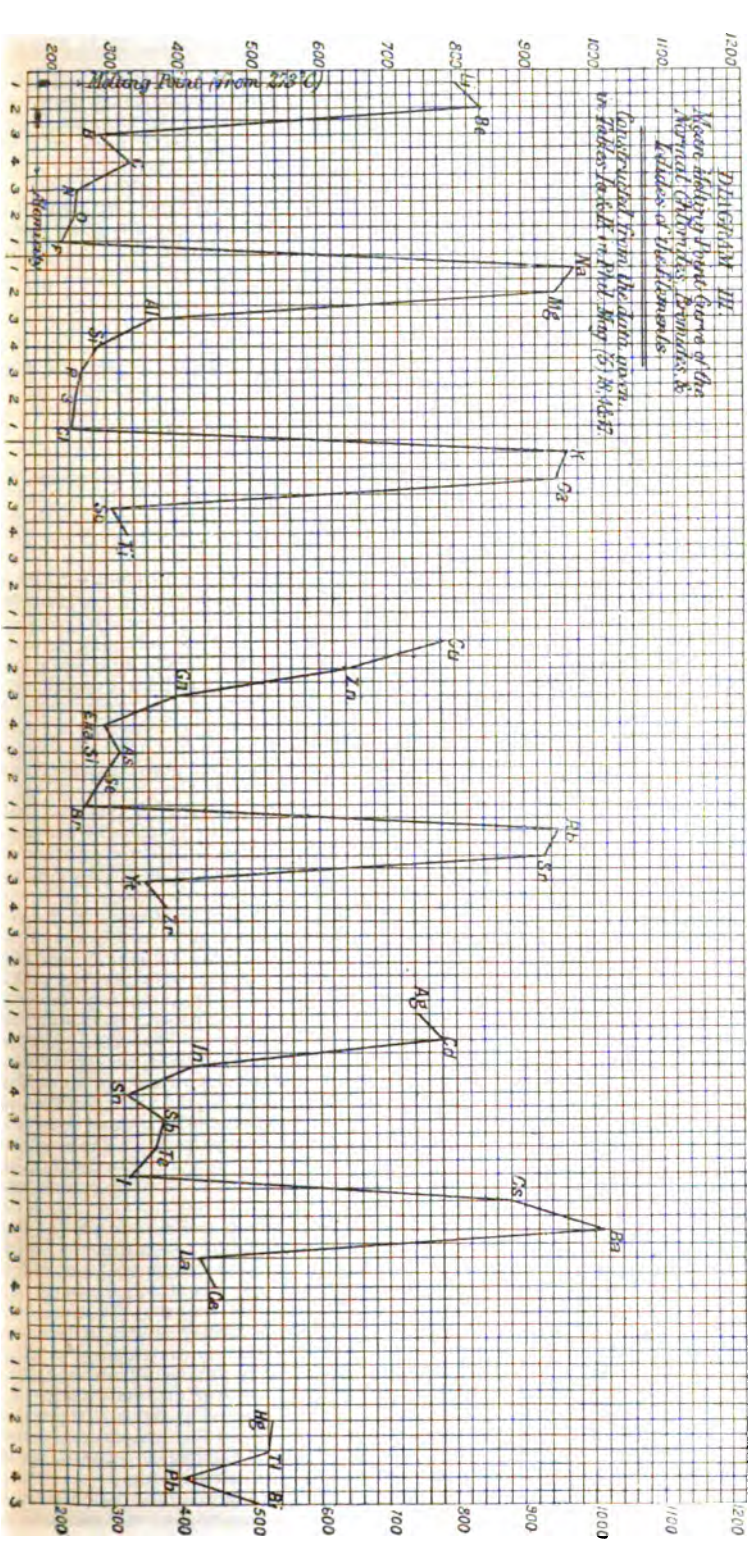
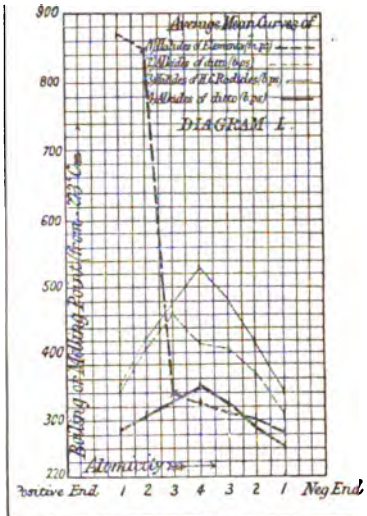


DIAGRAM III.
Melting Point (from 220° C.)
Atomicity
Li
Be
B
C
N
O
F
Na
Mg
Al
Si
P
S
Cl
K
Ca
Ti
Cu
Zn
Ga
Ge
As
Se
Br
Rb
Sr
Zr
Ag
Cd
In
Sn
Sb
Te
I
Cs
Ba
La
Ce
Ta
W
Os
Ir
Pt
Au
Hg
Tl
Pb
Bi


Average Mean Curves of
DIAGRAM I.
Atomicity
Positive End.
Neg End.

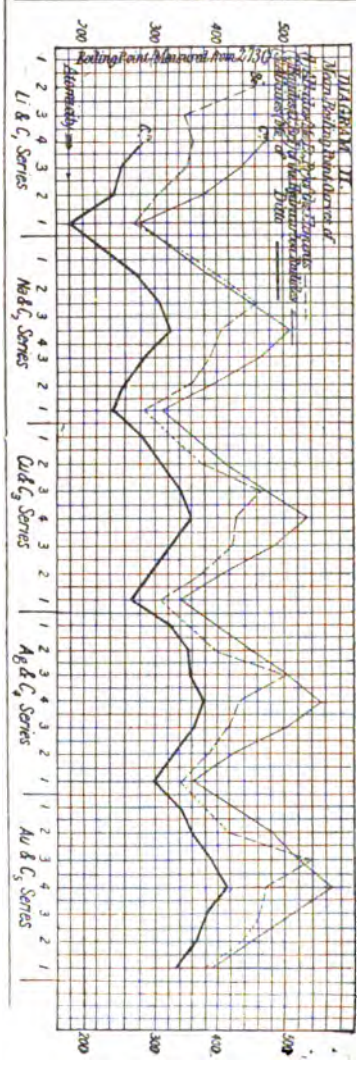


DIAGRAM II.
Melting point Mineral from 270°
Atomicity
Li & C, Series
Na & C, Series
Cu & C, Series
Ag & C, Series
Au & C, Series

alkides (methides only) of ditto. Diagram III.* gives the mean curve of the melting-points of the chlorides, bromides, and iodides of the elements.

A very marked feature in the curves of the halides of the elements, as shown by Diagram III., and more especially by Diagram I., is the sudden and great rise in melting-point (the same also holds true for the boiling-point) which occurs at the positive end of each series as we pass from triad to dyad, and thence to monad, metals. What may be the cause of this it is very difficult to say. The only explanation which occurs to me is that it may possibly be due to polymerisation, in which case the molecules of the halides of the alkaline and alkaline-earth metals, also of Ag, Cu, Zn, Cd, &c., would not be really represented by their ordinary simple formulæ, but by some multiple thereof,—*e.g.*, $(NaCl)_n$, $(KBr)_n$, &c. In this connection note the abnormally high boiling-point of C_2Cl_2 in the second series of the chlorides of the hydrocarbon radicles, and already referred to in my first paper, and shown in the diagram accompanying that paper. This compound stands on a part of the curve corresponding to that occupied by $MgCl_2$ in the curve of the halides of the elements, and its high boiling-point is undoubtedly due to its being a polymer $(C_2Cl_2)_n$. For a similar reason may not the abnormally high melting-point of $MgCl_2$ be due to its being really a polymer $(MgCl_2)_n$? This explanation, however, is not altogether satisfactory, for C_2Cl_2 is a non-saturated compound, and could hence easily undergo polymerisation, whilst $MgCl_2$ is, so far as known, a saturated compound.

2. A second point in which the elements of Table VIII. differ from the hydrocarbon radicles of Table IX. is that the groups in the former, though frequently, are not always numerically homologous, whereas in the latter case they are strictly so throughout. (If, however, the arrangement of the hydrocarbon radicles in Table XI. be adopted, this statement would require some modification.

3. In the case of the elements each group is divisible into two sub-groups, because, as pointed out by Mendeljeff, it is only the alternate members of a group which are strictly comparable with one another. The several series of elements in Table VIII. are therefore printed alternately in thin and thick type.

(To be continued).

NOTE ON THE REACTION OF TIN WITH SULPHURIC AND NITRIC ACIDS.

By H. BASSETT.

THE formation of stannic sulphate by the action of sulphuric acid alone on tin requires, as is well known, a high temperature: the addition of a small quantity of nitric acid, which readily supplies the necessary oxygen, greatly facilitates the action, and was long ago applied in the manufacture of the ornamental articles of tin-plate known as "Moirée metallique," the mixed acids dissolving a film of tin from the surface and exposing the crystalline structure of the metal.

A mixture of 1 part sulphuric acid, 2 parts nitric acid, and 3 parts water, all by measure, has a remarkable solvent action on tin in the cold. A solid lump of the metal weighing 10 grms. dissolves completely in a few hours in 50 c.c. of this mixture, the containing vessel being immersed in cold water. Under these circumstances no red fumes are given off, but a steady evolution of nearly pure nitrous oxide goes on the whole time. The resulting solution of stannic sulphate is quite clear unless the temperature has been allowed to rise, in which case it becomes beautifully opalescent, and if heated in the water-oven for an hour it becomes nearly solid and opaque.

On pouring the solution (still containing some nitric acid) into boiling water, the tin is completely precipitated in the form of gelatinous metastannic acid, which, after thorough washing with boiling water, dries up in the water-oven into semi-transparent lumps.

Attempts to utilise this reaction for the solution and analysis of tin alloys have not proved satisfactory: in presence of some metals a small quantity of tin appears to escape precipitation, while others show more or less tendency to go down with the precipitate.

ON THE SEPARATION AND THE DETERMINATION OF COPPER, CADMIUM, ZINC, NICKEL, &c.

By A. CARNOT.

COPPER, cadmium, zinc, nickel, cobalt, manganese, and iron may occur in certain ores and in a number of industrial alloys. Their successive separation in analysis presents great practical differences by reason of the analogous properties of their salts.

The methods of separation about to be explained are principally founded upon the use of sodium or ammonium hyposulphite, and on that of sulphuretted hydrogen in solutions successively acidified by sulphuric or hydrochloric acid, by oxalic acid, and, lastly, by acetic acid.

The precipitation of copper by sodium hyposulphite in a boiling sulphuric solution was first recommended by Flajolot as a means of separating it from zinc and nickel. Much more recently Vortmann found that the same reagent effects the separation of copper and cadmium with great exactitude.

The author has satisfied himself of this fact, under different conditions which appeared preferable and making use of ammonium hyposulphite, which in comparison with the sodium salt has the advantage of not introducing a fixed alkali.

The solution containing copper, cadmium, and other metals diluted to 200 or 300 c.c., is acidified with 10 to 15 c.c. hydrochloric acid, heated to boiling and mixed with hyposulphite, added in successive portions until the precipitate, instead of becoming at once a deep brown from the formation of copper sulphide, remains for some time white and milky, from the liberation of sulphur. When the liquid is cleared by boiling, the precipitate is collected on a filter. It contains all the copper as Cu_2S. It is dried, the filter is burnt, mixed with powdered sulphur, and ignited in a small crucible traversed by a current of dry hydrogen (H. Rose's apparatus). The sulphide is weighed, containing 79·87 of copper. The cadmium may be precipitated by sulphuretted hydrogen or ammonium hydrosulphate.

The separation of cadmium and zinc is effected by an analogous operation, care being taken that the solution contains no other free acid save oxalic acid, and that the precipitated sulphides are not mixed with oxalates.

It must be observed, to this end, that the zinc is precipitated as simple oxalate, scarcely soluble in ammonium chloride, whilst the cadmium forms in presence of ammonia a double oxalate, easily soluble in the same reagent. If we add beforehand 10 parts of ammonium chloride to 1 part of metal we may completely prevent the precipitation of cadmium by oxalic acid or ammonium oxalate. The operation may be thus conducted whatever are the relative proportions of zinc and cadmium.

The solution, supposed to be acid and but little diluted, is exactly neutralised with ammonia. An excess of salammoniac is then added, and about 2 grms. oxalic acid in solution, and the whole is boiled for some minutes. If the zinc is in notable quantity, and forms a crystalline

* The separate curves for the chlorides, bromides, and iodides respectively of the elements have already been given in an earlier paper (*Phil. Mag.*, v., 18, 1).

deposit of oxalate, it is separated by decantation and washed with a hot solution of ammonium chloride. If it is in very small quantity there may be no deposit to separate. The solution containing all the cadmium and a little zinc, diluted to 200 or 250 c.c. and raised to a boil, ought not to give any further precipitate. There is then added at once or in several portions ammonium hyposulphite, acidifying afresh, if needful, with oxalic acid, and it is kept at a boil as long as the orange precipitate of cadmium sulphide appears to increase.

Each fresh addition of the reagent gives rise at first to a milky white precipitate of sulphur, which gradually turns orange. We ascertain that the precipitation is complete by decanting a portion of the liquid through a filter, adding a little more hyposulphite and oxalic acid, and boiling again. It ought to give merely a white turbidity, and finally a light yellow deposit of sulphur.

The sulphide of cadmium thus formed is dense, not bulky, easy to wash by decantation, and is totally free from zinc.

It is re-dissolved in dilute boiling nitric acid, the solution is evaporated to dryness in a small tared capsule, re-dissolved in a little dilute sulphuric acid, evaporated again, calcined below a red-heat, and weighed as cadmium sulphate containing 53·84 per cent of metal.

The zinc is found entirely in the oxalic solution and in the first crystalline precipitate. The latter is calcined separately, and converted into zinc oxide. The zinc in the solution is precipitated by a current of sulphuretted hydrogen. The whiteness of the precipitate shows that the liquid did not contain a trace of cadmium. It is filtered, dried, the filter burnt, and the whole ignited in a small Rose's crucible traversed by a current of dry hydrogen sulphide. The zinc sulphide, the sulphate which may have been formed during the combustion of the filter, and the oxide derived from the decomposition of the oxalate, are all brought to the state of sulphide containing 67·13 per cent of zinc.—*Comptes Rendus* (cii., p. 621).

THE DIASTATIC ACTION OF SALIVA, AS MODIFIED BY VARIOUS CONDITIONS, STUDIED QUANTITATIVELY.*

By R. H. CHITTENDEN and HERBERT E. SMITH.

(Concluded from p. 163).

b. Influence of Free Acid.

In view of the fact that some time ago one of us† was of the opinion that small percentages of acid‡ tended to increase the diastatic action of saliva, it was of especial interest now to ascertain definitely whether free acid when present in small percentages does invariably retard diastatic action. Langley and Eves state that "although saliva neutralised to litmus sometimes shows an increase of action on the addition of 0·0005 to 0·001 per cent HCl; yet if the proteids of the saliva be saturated with acid, there is a diminution of its amylolytic action, although no free acid is present in the saliva." This we cannot regard as correct without qualification, since our experiments appear to show that saliva with its proteid matter saturated with acid has a greater diastatic action in a given time than saliva simply neutralised, provided the percentage of acid-saturated proteids is not too large. The same investigators further state "that 0·0015 per cent HCl distinctly diminishes the amylolytic action of ptyalin," and "since 0·0015 per cent HCl increases amylolytic action it seems very unlikely that 0·005 per cent should increase it;" but as Langley and Eves, in studying the influence of free acid, apparently used diluted neutralised saliva, in which the proteids present were not combined with acid, depending simply upon dilution to avoid the influence of these bodies, it seems to us a little uncertain whether their results are strictly accurate on this point, since saliva even very much diluted does contain some proteid matter. They, however, state in this connection that "we have often found that solutions which we have thought carefully neutralised have been increased in action by the presence of still smaller percentages of acid, viz :— 0·0005 to 0 0010 per cent." Here, however, so far as their results show, the observed increase of activity may have been due to the small amount of acid-proteid matter present, certainly could not have been due wholly to free acid.

We have tried a large number of experiments on this point in a variety of ways, all of which tend to show that a very small trace of free acid, when the amount of acid-proteids is not large, does, seemingly, slightly increase the diastatic action of the ferment. It is, perhaps, questionable, however, whether in the use of such small percentages of acid, the results are to be strictly depended upon. The presence of a small amount of phosphate in the starch, or a trace of alkali, not to be detected by litmus, might easily neutralise the small amount of acid added. Again, non-saturation of the proteids to only a very slight extent might effect the result. We subjoin two or three of our experiments.

SERIES XX.

20 c.c. filtered saliva were neutralised and then sufficient acid added to combine with the proteids present; the mixture then diluted to 100 c.c. The solution contained 0·0114 grm. combined HCl, but no free acid. (A).

20 c.c. of the same filtered saliva neutralised, and the proteids just saturated with acid. 3·1 c.c. 0·1 per cent HCl were then added and the mixture diluted to 100 c.c. The solution contained 0·0114 grm. combined HCl, and in addition 0·0031 grm. free HCl. The solution gave a distinct violet with tropæolin oo. (B).

Digestions were made, using 1 grm. starch in a volume of 100 c.c. Time, thirty minutes. Following are the results.

	A.		B.	
Amount diluted saliva. C.c.	Wt. Cu in one-eighth. Grm.	Total amt. sugar. Grm.	Wt. Cu in one-eighth. Grm.	Total amt. sugar. Grm.
20	0·0988	0·4024	0·0972	0·3960
10	0·0917	0·3736	0·0921	0·3752
5	0·0826	0·3368	0·0861	0·3512

Amount diluted saliva.	Starch converted. A.	Starch converted. B.	Free HCl in B.
20 c.c.	36·23 p.c.	35·65 p.c.	0·00062 p.c.
10	33·53	33·78	0·00031
5	30·32	31·62	0·00015

Here there can be no question but that there was free acid in B. The saliva gave a distinct reaction with tropæolin oo and the starch used was apparently neutral. In this instance 0·0006 per cent free acid slightly diminished the diastatic action, while 0·0003 per cent slightly increased it.

A second experiment of like nature gave the following results :—

SERIES XXI.

20 c.c. filtered saliva were neutralised and the proteids exactly saturated with HCl, then diluted to 100 c.c. The solution contained 0·0073 per cent combined HCl, but no free acid. (A).

20 c.c. of the same saliva neutralised and the proteids saturated by the addition of the same amount of acid as in A; 1·2 c.c. 0·1 per cent HCl were then added, so that a distinct tropæolin reaction could be obtained in the 41 c.c. of fluid. The fluid was diluted to 100 c.c. and then contained 0·0012 per cent free HCl. (B).

20 c.c. of the same saliva neutralised and the proteids

* From *Transactions Connecticut Academy*, vol. vi., March, 1886.

† Chittenden and Griswold, *loc. cit.*

‡ Considered as 0·005 per cent, although we now know the above figure could not represent free acid, owing to the proteid matter of the saliva.

exactly saturated with acid; then enough more acid added to give a distinct tropæolin reaction, after which the solution was diluted to 100 c.c. The 100 c.c. of fluid contained exactly 0·003 grm. HCl. (C).

A drop of the latter fluid on being tested gave a distinct violet with tropæolin 00.

Following are the results of digestions made with the oregoing solutions of saliva.

Amount of diluted saliva.	Starch converted. A.	B.	C.
20 c.c.	35·65 p.c.	35·58 p.c.	35·36 p.c.
10	33·71	33·27	34·14
5	28·81	29·53	30·32

Here it is seen, as before, that the smaller percentages of free acid arising from the use of 5 and 10 c.c. of saliva, show a distinctly increased diastatic activity, while with 20 c.c. the results are very nearly identical; too large an amount of free acid to increase the action and yet not enough to materially diminish it.

We next tried the influence of *increased* percentages of free acid on the action of ptyalin.

Series XXII.

30 c.c. filtered saliva were neutralised and the proteids just saturated with acid, then diluted to 150 c.c.; 10 c.c. of this diluted saliva equal to 2 c.c. of the original saliva were used in each digestion. Following are the results, after warming with starch at 40° C. for thirty minutes in the presence of the percentages of free acid specified. The acid solutions were mixed with the starch previous to the addition of the saliva.

Per cent free acid.	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
0	0·0919 grm.	0·3744 grm.	33·71 p. c.
0·0006	0·0924	0·3768	33·92
0·0010	0·0773	0·3152	28·37
0·0020	0·0166	0·0744	6·69
0·0030	trace		

Here a slight increase is noticed with 0·0006 per cent followed at 0·002 per cent by a rapid fall in diastatic action.

With stronger solutions of ptyalin like results were obtained as follows:—

Series XXIII.

Filtered saliva was neutralised and the proteids just saturated with HCl. An amount of this fluid equivalent to 5 c.c. of the original saliva was used in each digestion. In this amount there was present 0·00266 grm. combined HCl, but no free acid whatever.

Following are the results of digestions with this saliva in the presence of the percentages of free acid specified.

Per cent free acid.	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
0	0·0956 grm.	0·3896 grm.	35·07 p. c.
0·0005	0·0966	0·3936	35·43
0·0010	0·0867	0·3536	31·80
0·0020	0·0162	0·0728	6·55
0·0030	trace		

Increasing now the amount of saliva still further, so that the percentage of combined acid reaches a point where its retarding influence begins to be felt, the presence of the smallest amount of free acid then causes at once a dedided decrease in diastatic action. Thus, using the same saliva as was employed in the preceding series, only in such quantity 20 c.c. of original saliva were present in each digestive mixture, it was found that the free acid produced a much greater retarding effect than before. The percentage of combined hydrochloric acid, in the form of acid-proteids contained in each digestive mixture was 0·01064 per cent. Following are the results of the diastatic action.

Per cent free acid.	Wt. Cu in one-eighth.	Total amount sugar.	Starch converted.
0	0·0972 grm.	0·3960 grm.	35·65 p.c.
0·0005	0·0830	0·3384	30·46
0·0010	0·0410	0·1712	15·41
0·0020	0·0061	0·0328	2·95
0·0030	trace		

This result accords with the statement made by Langley and Eves, "that if the proteids of saliva be saturated with acid there is a diminution of its amylolytic action, although no free acid is present in the saliva. This diminution is made more marked by the addition of the smallest quantity of hydrochloric acid." The above quantitative results plainly testify to the accuracy of the latter part of their statement. As to the action of the acid-saturated proteids that is wholly dependent upon the percentage present.

c. Destructive Action of Free Acid.

It has been clearly shown* that acid approximating to the strength of the acid of the gastric juice has a destructive action on the salivary ferment. Smaller percentages of acid have a like destructive action. It has at the same time been shown that the presence of very much smaller percentages of free acid stops the amylolytic action of the ferment. Is this stopping of the amylolytic action in every case due to destruction of the ferment, or simply to the retarding action of its presence? Langley, by using an aqueous extract of the parotid of rabbits, with but little proteid matter, concluded that the presence of 0·014 per cent hydrochloric acid is sufficient to destroy all but the merest trace of ferment in five minutes at 39° C. This before the action of acid-proteids was known. Chittenden and Ely, by experimenting with human saliva, came to the conclusion "that there may be in the presence of a *very dilute* acid a simple stopping of the diastatic action, without destruction of the ferment;" in other words, the retarding influence of very small percentages of free acid is not necessarily due to destruction of the ferment. Langley and Eves, criticising this conclusion, state "that since Chittenden and Ely apparently used unneutralised saliva, and took no account of the proteids present, it seems to us probable that not only was there no free hydrochloric acid in their experiments, but that even the proteids were not saturated with acid." In the article to which they refer it is, however, explicitly stated in a footnote† that the saliva was neutralised, and then an amount of acid added to equal 0·025 per cent. Unfortunately we did not know then of the action of acid on the proteids of the saliva; consequently the above percentage must have been mainly in the form of combined acid. Still the smaller percentages of free acid do not show great destructive action; their power of retarding the action of the ferment is out of all proportion to their power of destruction. Amylolytic action is almost entirely stopped by the presence of 0·002 per cent free hydrochloric acid, but warming saliva at 40° C. with 0·002 or even 0·005 per cent hydrochloric acid for thirty minutes causes little if any destruction of the ferment. On neutralisation, diastatic action goes on as vigorously as ever.

This is well illustrated by the following experiments:—

Series XXIV.

20 c.c. of filtered saliva were neutralised, the proteids just saturated with acid, and the mixture diluted to 100 c.c. The solution contained 0·007 per cent combined HCl.

10 c.c. of this diluted saliva were warmed with the specified percentages of acid for a definite time, then neutralising and equalising mixtures were added, and the diastatic action determined.

* Chittenden and Griswold, *loc. cit.*; Chittenden and Ely, *loc. cit.* Langley, *loc. cit.*

† *Amer. Chem. Jour.*, vol. iv., p. 119.

Following are the results:—

Length of time at 40° C.	Per cent of free HCl.	Starch converted.
30 minutes	0	32·63 per cent.
30	0·001	34·08
30	0·002	31·38
60	0·002	32·48
30	0·005	31·27
30	0·010	4·60
30	0·030	Complete destruction.

Although the results are for some reason a little irregular it is very evident that up to 0·005 per cent of free acid there is, under these conditions, no particular destruction of the ferment. With 0·010 per cent, on the other hand, the destruction is very great.

As to the bearing which these results have on the possible amylolytic action of saliva in the stomach, it is plain that when the fluids of the stomach acquire an acid reaction, due to the presence of free hydrochloric acid, ptyalin will soon be destroyed. In the first stage of digestion, however, when there is no free acid, the conversion of starch into sugar can undoubtedly go on, and at this stage of the process the proteid matter present may act as a shield to protect the ptyalin, and at the same time to stimulate it in its action; but as the acid-proteids increase in amount, and come nearer and nearer to their saturation point, it is possible that diastatic action may entirely stop even before free acid makes its appearance. Certainly all salivary ptyalin must ultimately be destroyed in the stomach.

General Conclusions.

1. The diastatic action of saliva can be taken as a definite measure of the amount of ferment present only when the dilution of the saliva in the digestive mixture is as 1:50 or 100. The limit of dilution at which decisive diastatic action will manifest itself with formation of reducing bodies is 1:2000—3000, under the conditions previously given.

2. The diastatic action of neutralised saliva is greater than that of normally alkaline saliva. The difference is particularly noticeable where the dilution is as 1:50 or 100, and is apparently out of all proportion to the amount of alkalinity.

3. Sodium carbonate retards the diastatic action of ptyalin in proportion to the amount of alkaline carbonate present. The percentage of alkaline carbonate, however, which hinders diastatic action can be designated only for definite mixtures, and not in a general sense, being dependent upon the dilution of the saliva and the consequent change in percentage of proteid matter.

4. The destructive action of sodium carbonate is modified materially by the dilution of the saliva, becoming greater the more the fluid is diluted. This result is due not to simple dilution, but doubtless to the diminished amount of proteids.

5. Neutral peptone has a direct stimulating effect on the diastatic action of neutral saliva.

6. The presence of small percentages of neutral peptone tends to raise the diastatic action of normally alkaline saliva to a point even beyond the action of the neutralised fluid; due in part doubtless to a loose combination of the alkali with the proteid matter, and also to a direct stimulation of the ferment. Likewise peptone tends to diminish in a similar manner the retarding action of the various percentages of sodium carbonate. To accomplish this, however, the amount of peptone must be proportionate to the percentage of alkaline carbonate.

7. Peptone tends to prevent the destructive action of dilute sodium carbonate on salivary ptyalin, thus giving proof of the probable formation of an alkaline-proteid body.

8. Saliva with its proteid matter saturated with acid appears to have a greater diastatic action than when simply neutralised, except when the acid-proteids thus formed are above a certain percentage. Small percentages of peptone saturated with acid similarly increase the diastatic action of neutralised saliva up to a certain point. Increasing the percentage of acid-proteids finally causes a diminution of diastatic activity.

9. The retarding influence of acid-proteids is out of all proportion to their power of destruction. Large percentages, however, of acid-proteids may cause almost complete destruction of the ferment.

10. The most favourable condition for the diastatic action of ptyalin, under most circumstances, appears to be a neutral condition of the fluid, together with the presence of more or less proteid matter. The addition of very small amounts of hydrochloric acid, however, to *dilute* solutions of saliva, giving thereby a *small percentage* of acid-proteids, appears to still further increase diastatic action. Under *such conditions* a minute trace of free acid appears to still further increase the action.

11. 0·003 per cent free hydrochloric acid almost completely stops the amylolytic action of ptyalin. The larger the amount of saturated proteids the more pronounced becomes the retarding action of free acids.

12. The retarding effects of the smaller percentages of free acid are not due wholly to destruction of the ferment. Pronounced destruction takes place with 0·005 to 0·010 per cent free hydrochloric acid.

13. Proteid matter, in influencing the diastatic activity of salivary ptyalin, acts not only by combining with acids and alkalies, but apparently also by direct stimulation of the ferment.

Sheffield Laboratory of Yale Cottage.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 150.)

Volumetric Estimation of Potash.

F. MOORE† has proposed to estimate the potash in K_2PtCl_6 by fusing with double its weight of sodium oxalate, dissolving the mass in water, and estimating the Cl volumetrically in the solution.

Koninck‡ has given a method of obtaining the whole of the chloride in a form easy of titration. He treats the hot aqueous solution of the K_2PtCl_6 with metallic magnesium. The platinum is precipitated with formation of magnesium oxide and escape of hydrogen. Titration is accomplished with silver nitrate, using potassium chromate as indicator.

M. Dubernard§ has lately proposed a new process for volumetrically estimating potash.

This method consists in precipitating the potash salt acidified by nitric acid with titrated solution of chloroplatinate of sodium and afterwards estimating the excess of this solution by a solution of nitrate of silver with previous reduction of the platinum salt remaining in solution by zinc. By reason of the favourable double decomposition secured by the employment of the chloroplatinate of sodium, the method is applicable to all potassium compounds—carbonates, sulphates, chlorides, nitrates, phosphates, &c. A solution of 12 to 15 per cent of chloroplatinate of sodium in alcohol diluted with an equal volume of water is employed. On the other hand, a solution of silver containing from 12 to 15 grms. of the nitrate per litre is used. Following is the method of titrating these solutions:—

Of the solution of platinum 10 c.c. are taken in a flask holding 100 c.c.; to this is added a small portion of zinc powder, and the solution is boiled for a minute; all the

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

† *Zeit. Anal. Chem.*, vol. xii., 137.

‡ *Revue Universelle des Mines*, vol. ix., No. 2.

§ *Annales Agronomiques*, vol. ix., No. 7, p. 326 *et seq.*

platinum is then precipated, and there remains in solution chloride of zinc and chloride of sodium. The volume is now made up to 100 c.c. with distilled water. The chlorides in one half of the filtered liquid are then precipitated by the silver solution. Suppose it takes 40 c.c.; multiplying this number by 4 we have 160 c.c., which represents 20 c.c. of the solution of platinum.

Weigh out exactly 0·5 grm. of a chemically pure salt of potassium, nitrate or sulphate; dissolve this salt in a flask of 100 c.c. capacity, in a few c.c. of distilled water, add a little nitric acid, and then precipitate the potassium with 20 c.c. of the platinum solution; make the volume up to 100 c.c. with alcohol of 95 per cent, filter 50 c.c., reduce at a boiling temperature with a little powdered zinc, make up to 100 c.c. The titration by the silver salt obtained with the 50 c.c. of the filtered liquid (or 12 c.c. multiplied by 4 equals 48), subtracted from the original silver titration 160, will represent the chlorine precipitated in the state of chloroplatinate of potassium by 0·5 of a grm. of the nitrate or sulphate of sodium; or 160 minus 48 equals 112 c.c., representing 0·5 of a grm. of nitrate of potassium, or 0·232 of oxide of potassium. For the estimation of any potash salts whatever, proceed exactly in the way which has just been indicated, taking 10 c.c. of the solution of 0·5 grm. of the sample in 100 c.c. The estimation of the chlorides pre-existing in the sample is to be made with the same silver solution (which must be titrated for this purpose), and the number of c.c. found for the half-grm. is to be subtracted from the titre of the silver salt found after reduction by zinc.

Example.—Given 27 c.c. found after reduction by zinc, and 8 c.c. found in the half-grm. of the potash salt, then we will have $27 \times 4 = 108$, $108 - 8 = 100$, and—

$$\frac{100 \times 0{\cdot}232}{112} = 0{\cdot}2076 \text{ for } 0{\cdot}5 \text{ grm.},$$

or 41·52 per cent. of potassium oxide.

Dr. Wiley has had the above method carefully tried by Mr. A. E. Knorr, who finds that the difficulty of determining the end-reaction makes the estimation of the chlorine very uncertain. He is now engaged in some modifications of the process, by means of which he hopes to reach a satisfactory degree of accuracy. The process, if it can be made reliable, is very quick and easy of application.

The Committee believe they have collected in the foregoing notices all the chief processes of determining potash that have any novelty or promise of success. In addition they give some of the results obtained by the application of these principles and variations of them to the analyses of commercial fertilisers.

Dr. C. A. Crampton made at the request of Dr. H. W. Wiley a series of determinations of potash in a commercial fertiliser by the following methods:—

(1) Two grms. were taken, transferred to a filter, and washed with successive portions of cold water of about 2 to 3 c.c. each until the filtrate measured 100 c.c. The entire filtrate was then treated with an excess of barium hydrate in solution, and allowed to stand on the water-bath for some time. A few drops of ammonium hydrate were then added, and a slight excess of a saturated solution of ammonium carbonate. After standing on the water-bath for some time, the mixture was filtered, the precipitate thoroughly washed with hot water, and after the addition of hydrochloric acid filtrate was evaporated to dryness and ignited at a low red-heat. The residue was treated with hydrochloric acid and water, filtered, the filtrate evaporated to dryness, and this operation was repeated until the residue showed little or no blackening on ignition. The residue was then dissolved in a small quantity of water, platinic chloride added in excess, evaporated nearly to dryness, treated with 80 per cent alcohol, filtered on a Gooch crucible, the precipitate washed with alcohol, dried for two hours at 100°, and weighed. A mean of thirty determinations by the above method gave 2·19 per cent of potash (K_2O).

(2) This method was exactly like the preceding, except that hot water was used for washing the samples instead of cold. A mean of fourteen estimations gave 2·91 per cent of potash (K_2O.)

It is therefore evident that cold water is as effective as hot in extracting the potash from the samples by the above methods.

(3) The samples of fertilisers were first ignited to low redness. After the organic matter was thus destroyed the subsequent treatment was the same as above.

Seven determinations were made, the mean of which showed 2·55 per cent of K_2O. This indicates that a portion of the potash was volatilised by ignition. It should be remembered, however, that the ignition was effected over an open flame and not in a muffle.

Two determinations made of the same sample of fertiliser as that used in the above experiments gave 3·07 per cent and 3·00 per cent K_2O respectively.

Mr. W. P. Wheeler made six determinations with the same sample, first igniting in a muffle just to incipient redness, and, after moistening with HCl, proceeding as by the Washington method.

Results.

	Per cent of K_2O.
No. 1	3·06
No. 2	3·04
No. 3	3·05
No. 4	3·02
No. 5	3·02
No. 6	3·01
Mean	3·03

These results show that no potash was lost by the previous ignition, and the Committee is of the opinion that previous ignition at a low temperature in a muffle can be practised without the use of sulphuric acid and with great benefit to the subsequent manipulation.

The object of the comparative trial was to determine the magnitude of the error arising from adding the ammonium carbonate to precipitate excess of barium, and separating the combined precipitate by a single filtration.

It appears from the above that the error amounts to 0·1 per cent. Perhaps by a very careful addition of the barium hydrate, so as to have only the slightest excess for commercial purposes, one filtration might be avoided.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Annual General Meeting, March 30th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

The President delivered an Address, of which the following is an abstract:—

The number of Fellows of the Society is now 1459, 31 of these being honorary foreign members. 111 new Fellows have been elected since the last Anniversary Meeting; 8 Fellows have withdrawn, 19 have been removed on account of arrears, and 16 have died, viz., one honorary foreign member, Prof. Hermann von Fehling, and Frederick Allen, Prof. Andrews, F.R.S., E. O. Brown, G. W. H. Clements, Frederick Field, F.R.S., James Higgin, Rev. S. Morris, James Parette, Thomas Spencer, Dr. E. G. Schweitzer, Surgeon-Major Sheppard, Henry Shepheard, Alfred Tribe, Dr. John Smith, W. S. Ward, and Walter Weldon, F.R.S.

104 papers have been communicated to the Society during the year: this is not only a great advance upon the previous year, when the number was 67, but is the

largest number hitherto attained with the one exception of 1880-81, when the number read was 113. The last number of *Transactions* is consequently one-third larger than that of the previous year. The President is inclined to think that this increased activity is due in no inconsiderable degree to the fact that the various new laboratories which have been established in the country during the last few years are now gradually entering upon their full duties; and he is of opinion that we may look forward with confidence to a continuous and steadily increasing development in the pursuance of scientific chemical work in this country.

New bookcases have been filled up at the Society's expense during the year, and thus considerable additional space has been secured for the library.

The subject catalogue of the library has just been issued to Fellows. The Council are greatly indebted to Prof. McLeod, F.R.S., and to Mr. Warington for the assistance they have rendered in preparing this catalogue, as well as to the Librarian, Dr. Thorne.

After dwelling on the recent incorporation of the Institute of Chsmistry by Royal Charter, the PRESIDENT expressed his gratification at being able to testify to the manifest progress in the activity of the Society and to the otherwise prosperous condition of its affairs. In conclusion he proceeded to discuss briefly the conditions which affect the cultivation of scientific chemistry in this country.

It was then moved by Dr. GLADSTONE, and seconded by Prof. THORPE, that the thanks of the meeting be given to the President for his Address, and that he be requested to allow it to be printed. Referring to the publication of the catalogue, Dr. Gladstone said that in looking through it he felt that it not only gave information as to what was, but also what was not, in the library, and it might well serve to lead many of us to make suggestions and to help to fill up gaps from our own shelves. The resolution was unanimously accepted, and was acknowledged by the PRESIDENT.

The Treasurer, Dr. RUSSELL, then read his Report, giving an explanation of the balance sheet. He said that the funds of the Society were in a satisfactory state, the income for the year having been £3743 and the expenditure £3108, leaving a balance in hand of £635, a sum that would make it possible to fund the life compositions received during the year.

Mr. CARTEIGHE moved that the thanks of the Society be tendered to the Treasurer for his services during the past year; this was seconded by Mr. FRISWELL.

Mr. CROOKES proposed a vote of thanks to the Auditors, which was seconded by Prof. CLOWES. Mr. MAKINS replied.

A vote of thanks to the Officers and Council having been proposed by Mr. H. B. DIXON, seconded by Mr. PICKERING, and acknowledged by Dr. ARMSTRONG,—

Mr. HOWARD moved that the thanks of the meeting be given to the Editor, Sub-Editor, Abstractors, and Librarian for their important services to the Society during the year; this was seconded by Mr. J. A. R. NEWLANDS. Mr. GROVES and Dr. THORNE replied.

Prof. Humpidge and Dr. Teed were appointed Scrutineers, and a ballot having been taken the Officers and Council for the ensuing year were elected (see *ante*, p. 166).

Thursday, April 1st, 1886.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Holland Crompton, 15, Belgrave Road, St. John's Wood, N.W.; George William Saul Hudson, Church Street, Settle, Yorkshire; A. Wentworth Jones, Godington Rectory, near Bichester; William Henry Pendlebury, B.A., Christ Church, Oxford.

The following papers were read:—

35. "*The Determination of Boiling-Points*," By Prof. RAMSAY and SYDNEY YOUNG, D.Sc.

Prof. Ramsay called attention to the device employed by Dr. Young and himself in determining boiling-points (*Phil. Trans.*, 1884, p. 471), which consists in encasing the thermometer bulb in cotton-wool or asbestos; in distilling a pure liquid, the temperature remains constant throughout, owing to the presence of a film of liquid on the thermometer bulb.

DISCUSSION.

Prof. RAMSAY, in reply to a question by Dr. JAPP, said that he was of opinion that in distilling mixed liquids the liquid of higher boiling-point very rapidly expels that of lower boiling-point from the wool, and that hence the proper temperature is indicated almost immediately.

36. "*The Vapour-pressures of Bromine and Iodine, and Iodine Monochloride.*" By Prof. RAMSAY and SYDNEY YOUNG, D.Sc.

After calling attention to the extremely discrepant statements as to the melting- and boiling-points of bromine and iodine, the authors describe their own observations.

Bromine.—The statements of various authors and books vary enormously, the melting-point of bromine being given as $-7{\cdot}3°$ by Regnault and as $-25°$ by Liebig, its boiling-point being stated as 58° by Andrews and 63° by Pierre—these being extreme values.

Two samples of bromine were examined by the authors after being submitted to purification. The melting-point directly observed was between $-7{\cdot}0$ and $-7{\cdot}45$, and from their results generally they infer that it is very near to $-7{\cdot}05°$: the boiling-point of the first sample was 57·65° at 749·8 m.m. pressure, that of the second was 58·85° at 755·8 m.m., but they incline to think that the latter contained some impurity,—perhaps a brominated carbon compound, and give as the corrected number 58°.

Iodine.—The melting-point of iodine was observed to be between 113·8° and 114·1, and they regard 114·15° as the true number; the boiling-point under 760 m.m. pressure was found to be 184·61°.

It was found impossible to obtain useful numbers for iodine monochloride, on account of its instability.

DISCUSSION.

The PRESIDENT remarked that the great discrepancies between many of the earlier determinations of the physical constants of bromine were probably due to the presence of bromine carbon compounds.

Mr. GROVES said that the boiling-point given by Mr. Bolas and himself (59·6°) was determined by using about 2 lbs. of very carefully purified bromine, which certainly contained very little, if any, carbon tetrabromide.

37. "*The Use of the Electric Light to Influence Chemical Change.* By HENRY E. ARMSTRONG.

It is well known that many chemical changes take place under the influence of light which do not occur under otherwise identical conditions in its absence. Schramm's recent experiments have proved that light has a most remarkable effect in influencing the direction of change in cases in which action takes place very readily both in presence and absence of light: thus whereas when chlorine acts on toluene in the dark, chlorotoluenes are formed, in sunlight benzyl chloride is produced; ethylbenzene is excessively sensitive, bromethylbenzene, instead of ethylbromobenzene, being obtained by the action of bromine even in diffused light, and if the treatment be continued in sunlight the dibromide. $C_6H_5{\cdot}CBr_2{\cdot}CH_3$, is produced, whereas cinnamene bromide,—

$$C_6H_5{\cdot}CHBr{\cdot}CH_2Br,$$

is formed if bromine be allowed to act on heated bromethylbenzene; in sunlight, pseudocumene is at once converted into the monobromide, $C_6H_3Me_2{\cdot}CH_2Br$, and more slowly into the dibromide, $C_6H_3Me(CH_2Br)_2$,

whereas mono-, di-, and tri-bromopseudocumene are formed in absence of light. Dr. Armstrong finds that, as was to be expected, the light of the electric arc may be substituted for sunlight. The influence of light may therefore be readily exhibited as a lecture experiment, as the product of the action of bromine in darkness on pseudocumene after removal of hydrogen bromide has no action on an alcoholic solution of silver nitrate, whereas the product obtained under the influence of light at once reacts with such a silver solution. It is merely necessary to drop the bromine into the hydrocarbon in a flask directly exposed to the rays from the arc. Owing to the uncertainty of sunshine, the complex arrangements which are necessary if it is to be used for any lengthened period, and the variation in its intensity, it is conceivable that the use of a powerful electric arc may be of considerable advantage in experiments on the influence of light in promoting or controlling chemical change, and even in some manufacturing operations.

38. "*Some Sulphur Compounds of Barium.*" By V. H. Veley, M.A.

It is shown by the results both of synthetical and analytical experiments that the monohydrate of barium hydroxide is converted into barium monosulphide in accordance with the equation—

$$Ba(OH)_2,H_2O + H_2S = BaS + 3H_2O;$$

known weights of the hydroxide were taken, and a certain weight of the sulphide and of water obtained.

By the action of hydrogen sulphide on an aqueous solution of barium hydroxide, a solution of barium hydrosulphide is formed, from which crystals of the composition $Ba(SH)_2,4H_2O$ separate out; this substance is far more stable than the corresponding calcium compound. The evolution of hydrogen sulphide is concomitant with that of water; when all the latter has been given off the retention of hydrogen sulphide by the anhydrous substance is most marked: only at a red-heat is all the hydrogen sulphide given off and the conversion of the hydrosulphide into the sulphide complete.

A warm saturated solution of barium hydrosulphide dissolves sulphur to give a red liquid, from which crystals of barium tetrasulphide, $BaS_4{\cdot}2H_2O$, separate.

Barium hydroxyhydrosulphide absorbs carbon disulphide, with formation of an unstable barium thiocarbonate.

Discussion.

Prof. Ramsay said that Mr. Veley's account reminded him that years ago, on dissolving sulphur in a solution of barium hydroxide, after crystallising out the thiosulphate, he obtained crystals like those described by Mr. Veley, but of the formula BaS_7.

Mr. Veley, in reply to Dr. Messel, said that he had examined the product made on a large scale by roasting barium sulphate with coal, &c., and had found the crystals to consist of barium hydroxyhydrosulphide with a slight excess of SH_2.

Dr. Teed added that he had always found barium and sulphur present in these crystals in the ratio Ba : S.

39. "*Parabenzylphenol and its Derivatives and a New Benzylphenol.*" By Prof. E. H. Rennie, M.A., D.Sc.

Dinitroparabenzylphenol has been further examined (comp. *Trans.*, 1882, xxxiii., 220); if gently warmed with concentrated nitric acid, it is converted into the trinitro-derivative, but on boiling it with the slightly diluted acid the smell of benzaldehyde is noticed and it is converted into trinitrophenol.

The oily residue left after purification of parabenzylphenol yields a sulphonic acid isomeric with that from parabenzylphenol; its potassic salt crystallises with $2\frac{1}{2}OH_2$. This salt is converted into a nitrosulphonate by nitric acid, and into a bromosulphonate by bromine; the nitrosulphonate is converted by nitric acid into an isomer of dinitroparabenzylphenol, and into a bromonitrobenzylphenol by bromine.

Discussion.

Dr. Armstrong said that the formation of trinitrophenol from dinitrobenzylphenol was analogous to that of dinitrobromophenol from bromonitrobenzylphenol; it was noteworthy that Prof. Rennie had described this latter reaction in 1882, although Widmann in his recent paper (*Ber.*, 1886, 278) speaks of the displacement of an alkyl radicle by NO_2—in the conversion of cumenylacrylic into paranitrocinnamic acid—as altogether without precedent. Prof. Rennie and he, in a communication to the Society in March, 1883, had shown that the supposed trinitrothymol was in reality trinitrometacresol; the formation of this latter body from dinitrothymol was a reaction precisely similar to that described by Widmann.

40. "*Amidodiphenylsulphonic Acid and Azo-dyes from Diphenyl.*" By Thomas Carnelley, D.Sc., and James Schleselman.

p-*Amido-diphenylsulphonic Acid*, $C_{12}H_8(NH_2){\cdot}SO_3H$.—Only one acid of this composition appears to be obtained by the action of strong sulphuric acid on *p*-amido-diphenyl (m. p. 49°) at a temperature of 130°. It is practically insoluble in cold, and but very slightly soluble even in boiling water. The *sodium salt*—

$$C_{12}H_8(NH_2){\cdot}SO_3Na + 2H_2O,$$

and the *barium salt*, $[C_{12}H_8(NH_2){\cdot}SO_3]_2Ba + 4H_2O$, are described.

The following azo-compounds prepared from the acid are described:—

Sodium phenol-p-*diazodiphenylsulphonate*—

$$HO{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{12}H_8{\cdot}SO_3Na.$$

This dyes wool and silk a beautiful yellow.

Sod. resorcinol-p-*diazodiphenylsulphonate*—

$$(HO)_2{\cdot}C_6H_3{\cdot}N_2{\cdot}C_{12}H_8{\cdot}SO_3Na.$$

This dyes silk, wool, and raw jute a beautiful orange.

Sod. quinol-p-*diazodiphenylsulphonate*—

$$(HO)_2{\cdot}C_6H_3{\cdot}N_2{\cdot}C_{12}H_8{\cdot}SO_3Na.$$

This dyes silk and raw jute a very pretty golden amber.

Sod. α-naphthol-p-*diazodiphenylsulphonate*—

$$HO{\cdot}C_{10}H_6{\cdot}N_2{\cdot}C_{12}H_8{\cdot}SO_3Na.$$

This dyes silk, wool, and raw jute a deep reddish brown.

Sod. β-naphthol-p-*diazodiphenylsulphonate*—

$$HO{\cdot}C_{10}H_6{\cdot}N_2{\cdot}C_{12}H_8{\cdot}SO_3Na.$$

This dyes silk, wool, and raw jute a brilliant red.

Discussion.

Professor Meldola remarked that a number of dyes were now prepared from benzidin (diamidodiphenyl), which were of considerable technical importance: Congo-red was one of the most valuable.

PHYSICAL SOCIETY.

March 27th, 1886.

Prof. W. G. Adams, Vice-President, in the Chair.

Mr. A. R. Wright was elected a Member of the Society.

The Chairman read a letter from Dr. Alder Wright, Secretary to the "Tribe Fund" Committee, in which reference was made to the scientific work of the late Mr. Alfred Tribe, and an appeal made for funds to aid in the maintenance and education of his family, which, owing to his early death, have been left in straitened circumstances.

The following communications were read:—

"*On an Arc Lamp convenient for Use with the Duboscq Lantern.*" By Prof. S. P. Thompson.

The old Duboscq lamp, though working well with a series of Grove's cells, is very unsuitable for use with currents from dynamos. Prof. Thompson has employed as a substitute in the Duboscq lantern a lamp commonly known as the "Belfast Arc Lamp." The result is all that can be desired as regards steadiness and regularity

The focussing, that is the adjustment of the arc so that it shall remain unchanged in position, is effected by a wheel below the lantern, which is moved by hand.

"*On a Modified Maxwell's Galvanometer.*" By Prof. S. P. Thompson.

The galvanometer consists of a light frame of copper upon which is a coil of wire. This is suspended between the poles of a horse-shoe magnet, and a piece of soft iron is placed within the coil, but free from it, which concentrates the magnetic force between the poles. The coil is suspended by two silver wires, by which it is in connection with two binding screws on the base of the instrument. This galvanometer is extremely simple in adjustment, and very dead beat; it has also the advantage of being affected to an inappreciable extent by neighbouring magnets and currents, with a current in its own coils; when no current is in it, it is of course quite unaffected. The reading is effected by the ordinary lamp, mirror, and scale arrangement.

"*On the Expansion of Mercury between* 0° *and* −39° C.' By Profs. W. E. Ayrton and John Perry.

On November 14th, 1885, Mr. G. M. Whipple gave the Society the results of the examination of thermometers down to the melting-point of mercury. There was, however, no evidence as to whether the contraction of the mercury continued uniform, as the thermometers were only compared with mercurial ones. The authors have therefore examined this point, and have made a series of comparisons of a mercurial thermometer, lent them by Mr. Whipple, with a constant-volume air thermometer, both immersed in a bath of frozen mercury, which was allowed to gradually become warm. The result obtained was that no certain deviation from a linear law could be detected in the expansion of mercury when temperature was measured by the increase of pressure required to keep a volume of air constant. Hence temperatures down to −39° C. may be correctly measured by a mercury thermometer the stem of which is graduated for equal volumes.

"*On the Expansion produced by Amalgamation.*" By Profs. W. E. Ayrton and John Perry.

It has been accidentally observed by the authors that the amalgamation of brass is accompanied by great expansive force. If the edge of a straight thick brass bar be amalgamated, it will be found that in a short time the bar is curved, the amalgamated edge being always convex, and the opposite concave. The authors imagine that a similar action may be the primary cause of the phenomena pesented by the Japanese "magic mirrors." Japanese mirrors are made of bronze, and have a pattern cast upon the back, and although to the eye no trace of it can be discovered upon the polished reflecting surface, yet, when light is reflected by certain of these mirrors on to a screen, the pattern is distinctly visible in the luminous patch formed. In a paper before the Royal Society they have shown that this is due to the polished side opposite the thinner parts of the coating being more convex than the others,—a conclusion verified by the fact that the pattern is reversed when formed by a convergent beam of light. Such a condition of things would evidently result from a uniform expansive stress taking place over the reflecting surface, the thinner—and consequently the weaker—parts becoming more convex or less concave than the others. The authors have hitherto attributed this inequality of curvature to a mechanical distortion to which the mirrors are intentionally submitted during manufacture, to produce the general convexity of the polished surface; but they now think it possible that the use of a mercury amalgam in the process of polishing may have an effect in the production of this inequality of curvature.

Action of Bromine and Water upon Levulose.—M. Honig.—The principal product is trioxybutyric acid. The production of formic and oxalic acids in appreciable quantities has not been observed.—*Ber. d. Deut. Chem. Gesell.*

CORRESPONDENCE.

THE SPECTRA OF ERBIA.

To the Editor of the Chemical News.

Sir,—Under the above title Dr. Humpidge informs us (Chemical News, vol. liii., p. 154) that he has observed the spectra of erbium and didymium in solid compounds containing these substances, when illuminated by ordinary daylight, the spectra being identical with the absorption spectra of the compounds in solution. He makes this statement in consequence of, and with reference to, the observation of Mr. Crookes that erbia, when illuminated with sunlight or electric light, gives a spectrum with dark bands.

In the *Journal of the Chemical Society* for 1882 (vol. xli., p. 210) occurs the following sentence referring to the mineral rhabdophane:—"When engaged in examining various specimens of British blendes, for the information of M. Lecoq de Boisbaudran in his search for sources of the metal gallium, Mr. Lettsom recognised the bands of didymium by examining with a pocket spectroscope the light reflected from the substance. The characteristic spectrum is easily seen when any didymium compound is so examined, even if the mineral be of a yellow or dark brown colour."

It must be nearly ten years since my friend Mr. W. G. Lettsom first showed me this new use of the pocket spectroscope. In the manuscript of the paper from which the above quotation is made I stated that the nature of this mineral was discovered by a novel use of the spectroscope: the remarks forwarded to me from the Publication Committee by the Editor of the Journal were in effect that this method of examination was not novel, though it might not have been published. As Mr. Crookes remarks in his paper, the only notice with reference to this property of erbia which he had met with was a passing remark of Prof. Clève's, that "the light reflected by dry erbia shows absorption bands."

Whether Prof. Clève or Mr. Lettsom first discovered this property in the rare earths, certainly it appears that Mr. Lettsom first obtained important results by an extensive application of it.—I am, &c.,

W. N. Hartley.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 12, March 22, 1886.

Instrument for Reproducing at will an Invariable Quantity of Electricity.—Marcel Deprez.—The instrument is a voltameter hermetically sealed and thus rendered independent of barometric, hygrometric, &c., fluctuations. The water decomposed by the current during each operation can be reconstituted afterwards by passing a spark between two wires sealed in the upper part of the tube.

An Absolute Spherical Electrometer.—M. Lippmann.—This apparatus consists of two concentric spheres of copper; that in the interior being formed of two movable hemispheres.

Calorimetric Study of the Metals at High Temperatures.—M. Pionchon.—The author gives his results in the form of a table.

Effluviography, or obtaining Images by the Effluve.—D. Tommasi.—The author submits the first results of

his researches on the means of obtaining, by the sole action of the electric effluve or obscure discharge effects such as are realised by the use of light in photography. The following arrangement has been provisionally used to photograph objects without the concourse of light, or, speaking more correctly, to *effluviograph* them. Two metallic brushes arranged parallel to each other are connected each to a pole of the Holtz machine. A gelatino-bromide plate of the same height is placed perpendicularly to the brushes, so that the plane of the sensitive surface contains the edges of these brushes or is very near to them in both directions. The current being established an exposure of some minutes is sufficient. This operation must of course be effected in absolute darkness. It only remains to develop and fix the impression obtained in the ordinary manner. This experiment tends to prove that the effluve produces the same effects as the ultra-violet rays. Consequently there must exist a connection between the two extreme parts of the spectrum, constituted by what the author calls provisionally electrical rays.

Separation and Determination of Copper, Cadmium, Zinc, Nickel and Cobalt, Manganese, and Iron.—Ad. Carnot.—This paper will be inserted in full.

Elements of Milk-Sugar in Plants.—A Müntz.—The author's results are that the gums and mucilages of plants, pectic bodies, &c., contain among the products of their fission galactose identical with that obtained from sugar of milk. These substances exist in vegetable food in such quantity that they can furnish the galactose which enters into the constitution of the milk-sugar secreted by the mammary glands of female herbivora.

Chlorophyll and the Reduction of Carbonic Acid by Plants.—C. Timeriazeff.—On treating an alcoholic solution of chlorophyll with nascent hydrogen (produced by means of zinc and acetic acid) we obtain a reduction product of a straw-colour if the solution is dilute, but if it is concentrated of a reddish brown by daylight, and of a fine ruby-red by lamplight. This substance has a well-defined spectrum characterised especially by the absence of that band I in the red which has hitherto been considered as the most stable peculiarity of all the derivatives of chlorophyll. The second peculiarity of this spectrum is a broad band occupying the place of the band II., and of the two intervals comprised between I. and II. and between II. and III. But the essential property of this substance is that of becoming rapidly oxidised in the air, and at the same time turning green, that is regenerating chlorophyll. It is evidently a body analogous to that which must exist in plants, since etiolated plants become green only by becoming oxidised at the expense of the oxygen of the air. The author gives this substance the provisional name of protochlorophylline, or, more briefly, protophylline.

On Certain Xylenic Derivatives.—A. Colson and H. Gautier.—The authors describe in this memoir the products of a more advanced chloridisation, and a method by which they have converted some of the chlorides into corresponding oxides.

On a Synthesis of Ammonium Cyanide by the Effluve.—A. Figuier.—A mixture of 1 vol. of formene and 2 vols of nitrogen was submitted to the action of the effluve. The formation of ammonium cyanide was quite distinct.

Oxidation of the Fatty Acids.—H. Carette.—In the oxidation of the fatty acids there is produced an acid of the formula $C_{10}H_8O_8$, identical with normal propylene-dicarbonic acid.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xiv., Part 11.

Examination of some kinds of Pumpkins.—Dr. R. Ullbricht.

Digestibility of Clover-Hay, Malt-Sprouts, and Cotton-Seed Meal.—H. P. Armsby.—From the *Amer. Journ. of Science.*

The Quantity of Volatile Acids Excreted by Ruminants.—H. Wilsing.—The total quantity thus eliminated in twenty-four hours is on the average 4 grms., equally distributed between the urine and the dung.

Investigation on Scorched Hay.—E. Mach and K. Portele.—The authors show the great loss of nutritive value which hay undergoes when it is heated to the verge of ignition.

Protective Inoculation against Rabies.—M. Pasteur.—An abstract of a communication made to the Academy of Sciences on October 26th, 1885.

On the Chemical Action of Light.—A. Vogel.—The author shows that cinchona-trees, growing in hot-houses in Europe, develop no quinine in their bark.

The Chemical Composition of the Pollen of the Scotch Fir (*Pinus Sylvestris*).—Dr. A. von Planta.—The pollen of the fir is much poorer in nitrogen, proteine, hypoxanthin, cane-sugar, and colouring matter than that of the hazel. On the other hand, it is richer in non-azotised matters, fatty acids, and starch.

The Occurrence of Choline in Hops.—P. Griess, G. Harrow, V. Griessmayer.—Choline is probably identical with lupuline. Griessmayer is of opinion that the hop contains neither ammonia, trimethylamine, nor choline as such, but merely lecithine. No case is yet known of choline having been obtained from a substance free from lecithine.

Examination of certain Tobacco-Leaves.—Dr. Niederstadt.—These two memoirs require merely to be mentioned.

MEETINGS FOR THE WEEK.

MONDAY, 12th.—Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "The Arts of Tapestry-Making and Embroidery," by Alan S. Cole.
TUESDAY, 13th.—Institution of Civil Engineers, 8
— Royal Institution, 3. "The Function of Circulation," by Professor Arthur Gamgee, M.D., F.R.S.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
— Society of Arts, 8. "Progress of the British Possessions in the last Quarter of a Century." by P.L. Simmonds.
WEDNESDAY, 14th.—Society of Arts, 8. "The Treatment of Sewage," by Dr. C. Meymott Tidy.
— Pharmaceutical, 8.
— Microscopical, 8.
THURSDAY, 15th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "Electro-Chemistry," by Prof. Dewar, F.R.S.
— Chemical, 8. Ballot for the Election of Fellows.
FRIDAY, 16th.—Royal Institution, 5. "Recent Progress in the Coal-Tar Industries," by Sir Henry E. Roscoe, F.R.S.
SATURDAY, 17th.—Royal Institution, 3. "Fuel and Smoke," by Prof. O. Lodge, D.Sc.

LONDON HOSPITAL AND MEDICAL COLLEGE, Mile End, E.—The SUMMER SESSION will commence on Saturday, May 1st. Intending students are advised that under the new regulations of the Royal College of Physicians and the Royal College of Surgeons, it is exceedingly advantageous to enter for the Summer Session. Students now entering are also eligible for the Entrance Scholarships in September.

The Hospital contains nearly 800 beds, and is the largest general hospital in Great Britain.

General fee for lectures and hospital practice, 90 guineas in one sum or 100 guineas in three instalments. The resident and other hospital appointments are free to full students.

Special entries may be made for medical and surgical practice, also for the course of practical surgery.

The London Hospital is now in direct communication by rail and tram with all parts of the Metropolis, and the Metropolitan, Metropolitan District, South Eastern, and East London Railways have stations within a minute's walk of the Hospital and College.

For prospectus and particulars apply to
MUNRO SCOTT, Warden.

THE CHEMICAL NEWS.

Vol. LIII. No. 1377.

THE SOLUBILITY OF SULPHUR IN ALCOHOL.

By ARTHUR G. BLOXAM.

The fact that sulphur crystallises from its solution in hot alcohol in a white prismatic form has not, it appears, been generally noticed in text-books; for Miller's "Inorganic Chemistry" is the only book at my disposal in which I can find it mentioned. This is the more surprising as it has become of considerable importance since the introduction of rubber corks.

I discovered this fact for myself while separating some fat and sulphur with alcohol, being surprised at the deposition of white crystals from the hot solution.

By dissolving sulphur in hot methylated spirit and allowing it to cool slowly in a vessel surrounded by hot water prisms of lengths up to half an inch were obtained; they were brilliantly transparent and so white that they might have been taken for crystals of nitre; but they had become quite opaque and pale yellow in the course of thirty-six hours although kept under the liquid; a low power of the microscope showed very beautifully the change into octahedra.

A more important bearing of the subject is in its relation to the use of rubber corks with alcohol. Mr. G. S. Johnson has called my attention to some crystals which he obtained in extracting a resinous body with alcohol, and which proved to be sulphur derived from the rubber cork connecting his flask and condenser. If a rubber cork be boiled with alcohol for fifteen minutes a good crop of sulphur crystals is obtained on cooling the liquid. It is evident that if alcohol be constantly distilled on to a rubber cork the resulting error will be still greater.

Chemical Laboratory, King's College,
April 7, 1886.

NOTE ON THE VALUATION OF ACETATE OF LIME.

By HARCOURT PHILLIPS.

The two chief processes in use at the present time for the valuation of acetate of lime are known as the "Phosphoric Acid Test," and the "English Commercial Test" or "Sulphate of Soda Test." The former, as is well known, consists in the distillation of the sample with phosphoric acid, and subsequent determination of the acetic acid in the distillate by means of standard caustic soda. In the sodium sulphate process the calcium acetate is converted into sodium acetate by means of sodium sulphate, and this again into sodium carbonate by ignition. The alkali so produced is finally titrated with standard acid, and the amount of acetic acid calculated from the data so obtained. The first of these processes may be made, as I hope presently to show, one of great accuracy. In the second, however, several sources of error are liable to creep in. Inasmuch as the ignition takes place in the presence of sulphates, there is always a danger of these being partially reduced to sulphides by the carbon of the ash, and thus cause an excess of acid to be used over that required by the sodium carbonate. Then, again, unless care be taken to neutralise the free lime which is often present in commercial samples, a result more or less above the truth may be obtained. On the other hand, there is danger of getting a low result through insufficient ignition, and consequent failure to completely convert the sodium acetate into carbonate.

I was lately requested to compare the two processes above mentioned, and in the course of my investigations was led to devise a modification of the "phosphoric acid test" which I think an improvement on the old method, and not liable to the possible errors attending the sodium sulphate process. As the process may prove of some use to chemists engaged in the valuation of acetate of lime, I herewith beg to describe it as conducted in my laboratory:—

One grm. of the sample is placed in a small retort holding about 100 c.c., the arrangement of which will be presently described. Ten c.c. of a 40 per cent solution of phosphoric acid is added, together with as much water as will bring the volume to about 50 c.c. The distillation is then commenced, the flame being so arranged that it may be carried on till not more than 5 c.c., or even less, of fluid remain in the retort. (This may be easily managed, without cracking the retort, by careful manipulation of the flame). At this point the source of heat is removed, and the retort allowed to cool somewhat: 50 c.c. of hot water are then added, and the distillation recommenced and conducted as before. A final distillation with a third 50 c.c. of hot water (making 150 c.c. in all) will be found sufficient to carry over the whole of the acetic acid. The distillate is then titrated with standard soda, using phenolphthaleine as an indicator.

It goes without saying that in making a test of acetate of lime by the distillation process, it is desirable, where economy of time is an object, or where many assays have to be made with the same apparatus, to get the acetic acid

off as quickly as possible. Quick work here means rapid distillation and a minimum of fluid to be distilled. Now rapid distillation with the retort, as usually arranged, is impracticable in the case of acetate of lime, owing to the serious frothing and error occasioned by spirting. The accompanying sketch shows the arrangement I have been in the habit of employing to obviate this difficulty.

The stem of the retort is covered with flannel to prevent loss of heat by radiation, and has the end curved and drawn off so as to pass easily into the condenser. The retort is closed by a caoutchouc stopper carrying a small funnel, the stem of which passes some little way into the retort. When the apparatus is in use the funnel is closed by means of a tapered glass rod, covered with a piece of india-rubber tube. The latter is securely attached to the glass rod by fine wire. This little expedient enables the analyst to replenish the retort with hot water without loss of time. Indeed the whole operation may be completed in from forty to forty-five minutes.

With regard to the strength of acid and alkali used for the titration, the former equalled 0·0079 gramme $Ca''(C_2H_3O_2)_2$ per c.c., and had a corresponding alkali to match it. The end-point was finally settled by means of solutions just half the above strengths, phenolphthaleine being used as an indicator.

The following numbers were obtained by the above

process, when working on carefully prepared, pure, dry sodium acetate. I should mention, however, that sulphuric acid was used to expel the acetic acid, in these experiments, and not phosphoric acid.

Amount of Sodium Acetate taken.	Percentage of Sodium Acetate found.
0·40 grm.	100·12
0·41	99·96
0·32	99·89
0·41	100·14
0·43	99·91
Mean	100·004

The following tests of commercial acetate of lime were all made on the dried and finely-powdered samples, which were kept in closed tubes, and portions removed as required. I attach some importance to the sample being in fine powder, since one containing much tarry matter is liable to enclose particles of acetate which might escape decomposition.

Percentage of Acetate of Lime in Dry Samples.

	By P_2O_5 test.	By Na_2SO_4 test.
No. 1.	65·63	68·43
2.	65·24	66·23
3.	65·37	66 86
4.	65·24	67·80
5.	61·50	66·70
6.	61·28	65·44
7.	62·99	69·38
8.	63·12	66·86

If the foregoing figures teach us anything, they show the necessity there is for a complete revision of the sodium sulphate process for testing acetate of lime. Under some conditions of the ignition the figures come out 2 per cent above those obtained by the distillation method. More frequently, however, the error is greater. Mr. Allen suggests, in the last edition of his admirable "Commercial Analysis," that the ash should, after ignition in a muffle, be moistened with hydrogen peroxide, so as to oxidise the sulphides. This is clearly a step in the right direction, and a closer approximation to the truth should follow its adoption. There is, however, this serious objection to any process involving the decomposition of the acetate by sodium sulphate, namely, that it accounts as acetate of lime some not well-recognised bodies which, like the acetate, give soluble sodium salts when treated with sodium sulphate. It is likely that bodies of the phenol class would act in this way.

If time and opportunity serve, I hope to be able to make some further experiments in this direction.

ON THE

FAILURE OF SULPHATE OF AMMONIA IN MANURING EXPERIMENTS.

By THOMAS BROWN.

WHILST seeking to determine by agricultural experiment the comparative manurial values of sulphate of ammonia and nitrate of soda, I have on several occasions during the past ten years obtained results not only unexpected, but inexplicable. Thus, equal plots have received—(*a*) the same gross weight of, (*b*) the same money values of, and (*c*) equal weights of nitrogen in, sulphate of ammonia and nitrate of soda. The two substances have been used for a variety of crops, sometimes sown as a top-dressing, at others drilled or ploughed into the soil. The resultant benefit to the crop has been most varying and most uncertain; occasionally, to my utter bewilderment, the application of nitrogen in the form of ammonium sulphate has been attended with but a comparative unimportant increase of crop.

In one set of experiments the results obtained from the use of nitrogen, as nitrate, have been far superior, at another equal, in a third inferior, to others obtained where the nitrogen was applied as ammonium sulphate.

I have long sought for the cause or causes of such variations in the results. The only unquestionable facts that presented themselves were—

(*a*.) The experiments demonstrating the inferiority of sulphate of ammonia were made on soils containing over 10 per cent of calcium carbonate.

(*b*.) When the ammoniacal salt has been applied to loams and clays the results were satisfactory.

(*c*.) Unfavourable results have generally followed the sowing of the ammoniacal salt on the surface soil.

(*d*.) Beneficial results have resulted when the salt has been applied to crops that allowed of the salt being buried by the harrow or the plough.

At first I concluded that during the process of nitrification a portion of the nitrogen of the ammoniacal salt was liberated as free nitrogen. That this was not a correct solution appeared when it was observed that on some occasions, on the same class of crop, the results obtained from the application of the ammoniacal salt were superior to those obtained from sodium nitrate. It afterwards suggested itself that a double decomposition might have taken place between the ammonium sulphate and the calcium carbonate in or on the soil to which the former was applied, ammonium carbonate and calcium sulphate being formed.

Several of the unexpected results were obtained from experiments conducted on the farm of Mr. F. I. Cooke, of Flitcham Abbey.

Early this year Mr. Cooke, at my request, kindly sent me 1 cwt. of the surface soil of one of the fields that had been under experiment, in order that at my leisure I might make more careful observations.

This soil I find contains over 17 per cent of calcium carbonate, and over 72 per cent of insoluble silicates: hence it is a light calcareous soil, similar to those occupying a great portion of the surface of West Norfolk. On mixing, in the laboratory, ammonium sulphate with portions of this soil, a strong smell of ammonia was in a short time apparent, becoming in half an hour very powerful. I next added ammonium sulphate in varying amounts to portions of this soil contained in large sized flasks, slightly raking the surface so as to mix the sulphate with the damp soil. In a few minutes ammonia was given off in sufficient abundance to instantly convert reddened litmus-paper deeply blue. This evolution of ammonia continued several days. In one flask the sulphate was covered by about an inch of fresh soil. In this flask no smell of ammonia can be detected, but slightly affected reddened litmus-paper.

I am continuing my observations. I wish to ascertain how much, and in what form, ammonia is liberated, and therefore lost, in definite periods when salts of ammonia are added to this and similar soils. I am also directing attention to the influence of rainfall on the amount evolved. But in the meantime it appears to me so important that this resulting action should be widely and immediately known, that I have determined to hand you these preliminary observations at once. For if ammoniacal salts are used indiscriminately and unwisely, the result will be an unjust condemnation of this valuable source of available nitrogen in agriculture. As an instance of a most unwise use, I would mention applying it as "a top-dressing to wheat crops" on chalk soils.

As I am not aware this action has been before observed by any experimenter, I make you this report in the hope that others may carefully investigate the matter.

Decomposition-Products of Hypophosphoric Acid.—A Joly.—The normal hydrate at the temperature of 70° is split up into metaphosphoric and phosphorous acids.—*Comptes Rendus.*

SUGGESTIONS AS TO THE CAUSE OF THE PERIODIC LAW, AND THE NATURE OF THE CHEMICAL ELEMENTS.*

By THOS. CARNELLEY, D.Sc.,
Professor of Chemistry in University College, Dundee.

(Continued from p. 172.)

As illustrations of this difference between odd and even series we have the following among others; (*a*) It is only the elements printed in thick type (including also the typical elements beginning with Li) which combine with alcohol radicles, those printed in thin type being devoid of that property.† (*b*) Elements printed in thin type are paramagnetic, whilst those in thick type are diamagnetic.‡‡ (*c*) Elements in thick type are generally easily reducible and frequently occur in the free state in nature, or when combined are usually found as sulphides or double sulphides, and only in very few cases as oxides; whereas elements in thin type are only reducible with great difficulty, and (except C, N, and O) *never* occur in the free state in nature, nor (except Mo, Mn, and O) as sulphides, but usually as oxides or double oxides, forming silicates, carbonates, sulphates, &c.§ (*d*) The colour relations,‖ also relations between the melting-points, boiling-points, heats of formation, &c.,¶ only hold good when alternate series are compared.

Now in the case of the hydrocarbon radicles of Table IX. no such difference in the properties of alternate series can be detected, for the members of any one group are all mutually comparable, and are not divisible into two sub-groups as in the case of the elements in Table VIII. (*cf.* however, Baeyer's observation, *vide infra*). Here we have a marked difference, but may it not be due to the series of hydrocarbon radicles in Table IX. being either all odd or all even series, the alternate even or odd series not being represented in the latter table? Such alternate series might be supposed to be generated as follows:—(See next column).

It will be observed that in the above table the system of odd and even series only becomes *complete* at series 10, though it commences *partially* at series 4. Now in the arrangement of the elements in Table VIII. the difference

TABLE XI.

Groups / Series.	I. Monads.	II. Dyads.	III. Triads.	IV. Tetrads.	V. Triads	VI. Dyads.	VII. Monads. H = 1	VIII.
0.								
1.	—	—	—	$CX_4 = 12$	$(CH)X_3 = 13$	$(CH_2)X_2 = 14$	$(CH_3)X = 15$	
2.	—	$C_2X_2 = 24$	$(C_2H)X_3 = 25$	$(C_2H_2)X_4 = 26$	$(C_2H_3)X_3 = 27$	$(C_2H_4)X_2 = 28$	$(C_2H_5)X = 29$	
3.	$(C_3H)X = 37$	$(C_3H_2)X_2 = 38$	$(C_3H_3)X_3 = 39$	$(C_3H_4)X_4 = 40$	$(C_3H_5)X_3 = 41$	$(C_3H_6)X_2 = 42$	$(C_3H_7)X = 43$	
4.	—	—	—	—	—	—	$(C_4H)X = 49$	
5.	$(C_4H_3)X = 51$	$(C_4H_4)X_2 = 52$	$(C_4H_5)X_3 = 53$	$(C_4H_6)X_4 = 54$	$(C_4H_7)X_3 = 55$	$(C_4H_8)X_2 = 56$	$(C_4H_9)X = 57$	
6.	—	—	—	—	—	—	$(C_4H_9)X = 63$	
7.	$(C_5H_5)X = 65$	$(C_5H_6)X_2 = 66$	$(C_5H_7)X_3 = 67$	$(C_5H_8)X_4 = 68$	$(C_5H_9)X_3 = 69$	$(C_5H_{10})X_2 = 70$	$(C_5H_{11})X = 71$	
8.	—	—	—	$(C_4H)X_4 = 74$	$(C_4H_2)X_3 = 75$	$(C_4H_3)X_2 = 76$	$(C_4H_3)X = 77$	
9.	$(C_6H_7)X = 79$	$(C_6H_8)X_2 = 80$	$(C_6H_9)X_3 = 81$	$(C_6H_{10})X_4 = 82$	$(C_6H_{11})X_3 = 83$	$(C_6H_{12})X_2 = 84$	$(C_6H_{13})X = 85$	
10.	$(C_7H)X = 85$	$(C_7H_2)X_2 = 86$	$(C_7H_3)X_3 = 87$	$(C_7H_4)X_4 = 88$	$(C_7H_5)X_3 = 89$	$(C_7H_6)X_2 = 90$	$(C_7H_7)X = 91$	
11.	$(C_7H_9)X = 93$	$(C_7H_{10})X_2 = 94$	$(C_7H_{11})X_3 = 95$	$(C_7H_{12})X_4 = 96$	$(C_7H_{13})X_3 = 97$	$(C_7H_{14})X_2 = 98$	$(C_7H_{15})X = 99$	C_8H_1
12.	$(C_8H_9)X = 99$	$(C_8H_{10})X_2 = 100$	$(C_8H_{11})X_3 = 101$	$(C_8H_{12})X_4 = 102$	$(C_8H_{13})X_3 = 103$	$(C_8H_{14})X_2 = 104$	$(C_8H_{15})X = 105$	
13.	$(C_8H_{11})X = 107$	$(C_8H_{12})X_2 = 108$	$(C_8H_{13})X_3 = 109$	$(C_8H_{14})X_4 = 110$	$(C_8H_{15})X_3 = 111$	$(C_8H_{16})X_2 = 112$	$(C_8H_{17})X = 113$	C_9H_1; C_9H_2; C_9H_3
14.	$(C_9H_{11})X = 121$	$(C_9H_{12})X_2 = 122$	$(C_9H_{13})X_3 = 123$	$(C_9H_{14})X_4 = 124$	$(C_9H_{15})X_3 = 125$	$(C_9H_{16})X_2 = 126$	$(C_9H_{17})X = 127$	
15. &c.	$(C_9H_{13})X = 121$ &c.	$(C_9H_{14})X_2 = 122$ &c.	$(C_9H_{15})X_3 = 123$ &c.	$(C_9H_{16})X_4 = 124$ &c.	$(C_9H_{17})X_3 = 125$ &c.	$(C_9H_{18})X_2 = 126$ &c.	$(C_9H_{19})X = 127$ &c.	$C_{10}H_1$; $C_{10}H_2$; $C_{10}H_3$; $C_{10}H_4$; $C_{10}H_5$

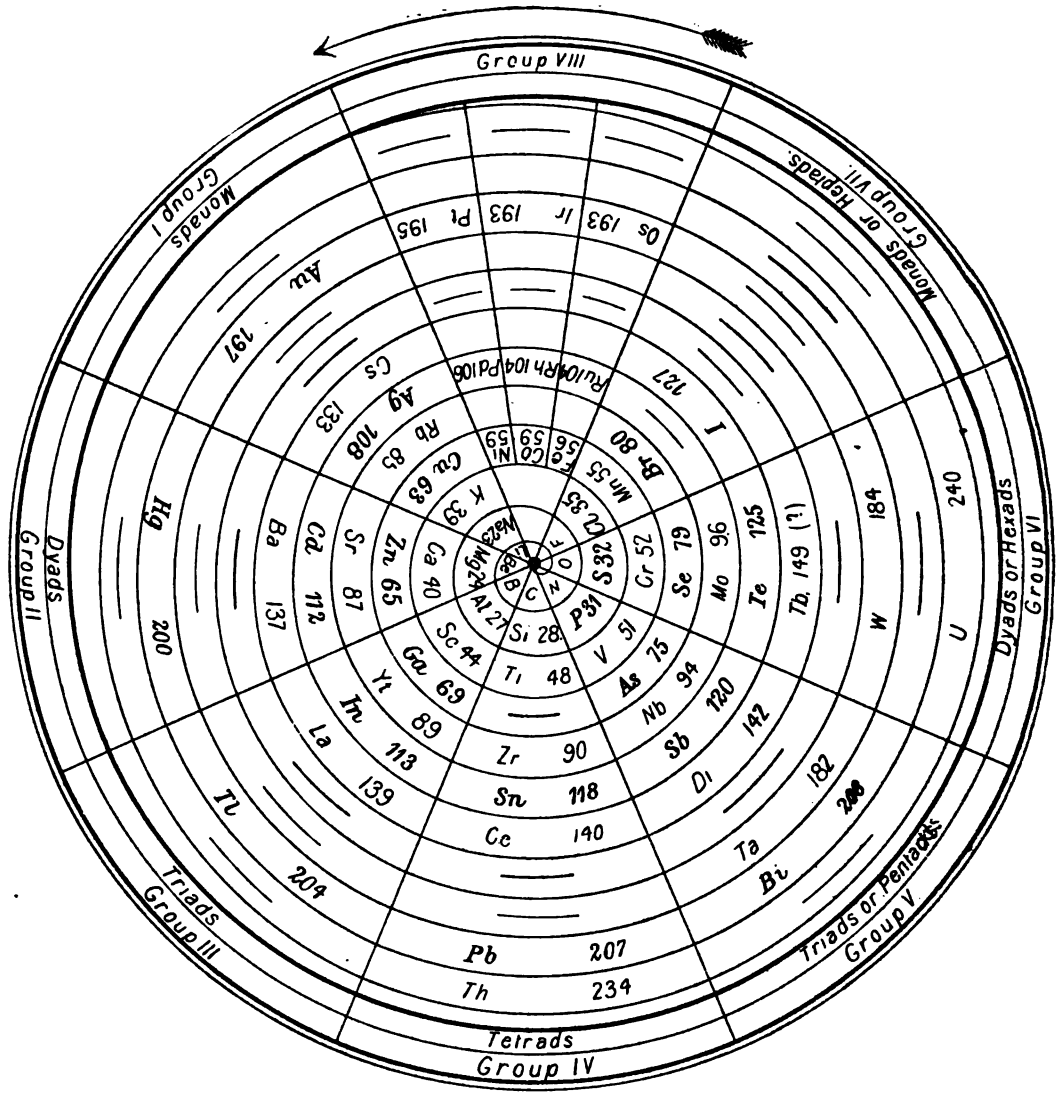
Formic acid series.	Melting-point. Even.	Odd.	Oxalic acid series.	Melting-point. Even.	Odd.
CH_2O_2		+8·6	—		—
$C_2H_4O_2$	+17		$C_2H_2O_4$	200	
$C_3H_6O_2$		*b.*−21	$C_3H_4O_4$		132
$C_4H_8O_2$	+1		$C_4H_6O_4$	180	
$C_5H_{10}O_2$		*b.*−16	$C_5H_8O_4$		97
$C_6H_{12}O_2$	−2		$C_6H_{10}O_4$	148	
$C_7H_{14}O_2$		−10·5	$C_7H_{12}O_4$		103
$C_8H_{16}O_2$	+16		$C_8H_{14}O_4$	140	
$C_9H_{18}O_2$		+12	$C_9H_{16}O_4$		106
$C_{10}H_{20}O_2$	+30		$C_{10}H_{18}O_4$	127	
$C_{11}H_{22}O_2$		+28·5	$C_{11}H_{20}O_4$		108
$C_{12}H_{24}O_2$	+43·6		—	—	
$C_{13}H_{26}O_2$		+40·5	$C_{17}H_{32}O_4$		132
$C_{14}H_{28}O_2$	+53·8				
$C_{15}H_{30}O_2$		+51			
$C_{16}H_{32}O_2$	+62				
$C_{17}H_{34}O_2$		+60			
$C_{18}H_{36}O_2$	+69				
—		—			
$C_{20}H_{40}O_2$	+75				
$C_{21}H_{42}O_2$		+72·5			
$C_{22}H_{44}O_2$	+78				

* A Paper read before the British Association, Aberdeen Meeting.
† Mendeljeff (*Annalen*, Suppl., viii., 133).
‡ Carnelley, *Ber.*, xii., 1958.
§ *Ibid.*, *Phil. Mag.*, (5), xviii., 197. *Ber.*, xvii., 2287.
‖ *Ibid.*, *Phil. Mag.*, (5), xviii., 132. *Ber.*, xvii., 2151.
¶ *Ibid.*, *Phil. Mag.*, (5), xviii., 6.

DIAGRAM IV.

ELEMENTS.

(Left handed Spiral)



between odd and even series only becomes evident about the middle of series 3.*

It is also interesting to observe in this connection that Baeyer (*Ber.*, x., 1286) has shown that, if the melting-points of homologous series be compared, this property is materially influenced by *odd and even numbers* in such a way that those compounds containing an *even* number of carbon atoms melt higher than the neighbouring compounds containing an odd number (see Table on preceding page, col. 1).

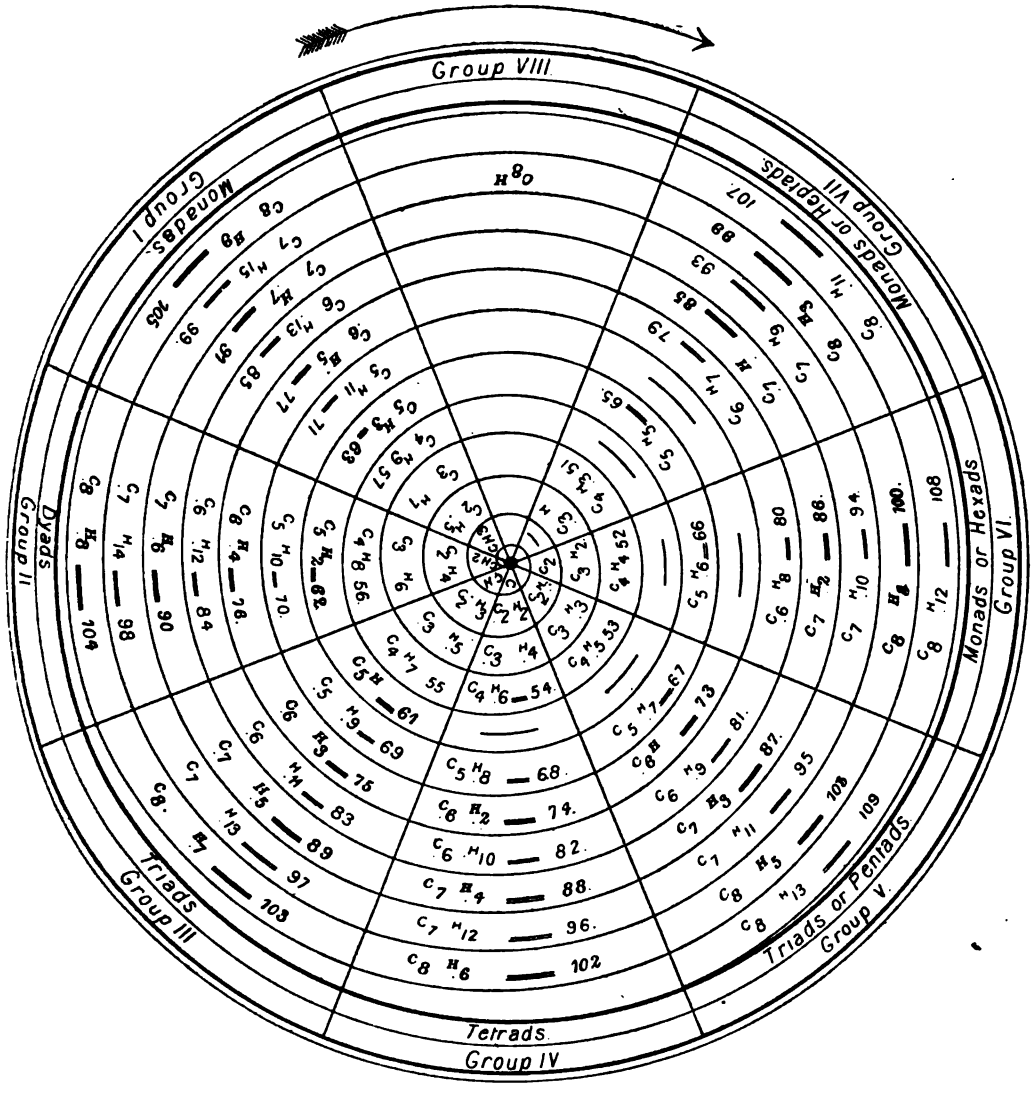
4. The last point of difference in the complete analogy of the elements of Table VIII. to the hydrocarbon radicles of Tables IX. or XI. that it will be necessary to mention is what may be called "inversion of the series." What is meant by this will be better understood from an inspection of Tables VIII. and IX. than from a written explanation. As there arranged the atomic weights of both tables increase across the tables from Group I. to Group VII., indicating thereby that methyl, ethyl, propyl, &c., are analogous to the halogens. And further, Groups I. II. and III. of the elements are represented as usually exhibiting but one atomicity, whilst Groups V., VI., and VII. are represented as triads or pentads, dyads or hexads, monads or heptads, respectively. In the Table of the hydrocarbon radicles, on the other hand, the conditions,

* *Cf.* the examples which have been given above in illustration of the difference between odd and even series of elements.

DIAGRAM V.

HYDROCARBON RADICLES.

(Right handed Spiral)



as regards to the atomicity of the several groups are reversed.

If, however, the hydrocarbon radicles in Table IX. be so arranged that the atomic weight increases across the table from Group VII. to Group I., instead of from Group I. to Group VII., then the condition of things as regards the atomicity of the several groups becomes the same in both tables. Under these circumstances, however, the alkyl radicles, methyl, ethyl, propyl, &c., are represented as analogous to the monad metals of Group I.

On the whole I am inclined to think that the analogy indicated by this latter arrangement is the truer one. It should be stated that whichever arrangement be adopted the relationships between the physical properties of the elements and their compounds and those of the hydrocarbon radicles referred to above in my previous papers, and the conclusions deduced therefrom, hold good in either case.

If the arrangement last proposed be adopted (*i.e.*, the one in which the atomic weights of the hydrocarbon radicles increase across the table from Group VII. to Group I.) then such an arrangement of the hydrocarbon radicles would bear the same relation to that of the elements in Table VIII. which a right-handed spiral bears to a left-handed spiral. Diagrams IV. and V. will make this clear. The spiral arrangement represented in IV. is in principle the same as that first adopted by Baumhauer (1870) and subsequently modified by Huth (1884). The

latter determines the position of the elements in the spiral by measuring off distances on the radii of the spiral proportional to the respective atomic weights.

(To be continued).

REPORT OF COMMITTEE OF THE CHEMICAL SOCIETY OF WASHINGTON, ON THE "METHOD OF STATING RESULTS OF WATER ANALYSES."

The Chemical Society of Washington, at the meeting of November 12th, 1885, appointed a Committee to consider the present state of water analysis, and to present a method of stating analyses adapted for general use, in order that those hereafter published may be readily compared with each other and with future work. This Committee reported February 11th, 1886, and was authorised to prepare an abstract for publication, in order to call the attention of chemists to the subject. The Society earnestly recommends the adoption of the scheme, which is herewith briefly presented. The full text of the Report will be published in the next *Bulletin* of the Society.

Abstract.

Water analyses are usually made to answer one of three questions, viz.,—

1st. Is the water useful medicinally?

2nd. Is it injurious to health? and

3rd. Is it suitable for manufacturing purposes?

Many books relating to water were published during the eighteenth century, but accurate chemical analysis was not attempted until about 1820. As the earlier analyses were isolated, rare, and made for special purposes, the form of the statement was of little importance if it was only intelligible. At the present time, however, water analyses are very numerous. An examination of about a thousand shows some forty-two methods of stating quantitative results, there being sometimes three different ratios in the report of one analysis. Such discrepancies render comparisons difficult and laborious. The various methods of statement may be classified under the following general forms:—

1. Grains per imperial gallon of 10 lbs., or 70,000 grains.

2. Grains per U.S., or wine gallon of 58,372 grains.

3. Decimally, as parts per 100, 1000, 100,000, or 1,000,000.

4. As so many grammes or milligrammes per litre.

The last two would be identical if all waters had the same density, but, as the densities of sea water, mineral waters, &c., are much above that of pure water, it is plain that the third and fourth modes are not comparable.

The Committee therefore unanimously recommends—

1st. That water analyses be uniformly reported according to the decimal system, in parts per million or milligrammes per kilogramme, with the temperature stated, and that Clark's scale of degree of hardness and all other systems be abandoned.

2nd. That all analyses be stated in terms of the radicals found.

3rd. That the constituent radicals be arranged in the order of the usual electro-chemical series, the positive radicals first.

4th. That the combination deemed most probable by the chemist should be stated in symbols as well as by name.

The abandonment of Clark's *scale* has been recommended by Wanklyn and Chapman, and the recommendation made by the Committee does not involve the disuse of his method, but merely the bringing of it into accord with the decimal system,—the changing from grains per gallon to milligrammes per kilogramme.

The last conclusion was deemed desirable from the frequent confusion in the statement of the iron salts and of the carbon oxides.

The Committee is unanimously of the opinion that analyses in the form recommended will prove quite as acceptable to boards of health, and to the public in general, for whom such analyses are often made, as if presented in the mixed and irregular forms commonly adopted.

The Committee also feels sure that people in general are better able to form a definite idea of the character of a water from a report stated in parts per 100, parts per 1,000,000, &c., than from one expressed as grains per gallon, the latter being a ratio wholly unfamiliar to any but those in the medical or pharmaceutical professions.

(Signed) A. C. Peale, M.D.
Wm. H. Seaman, M.D.
Chas. H. White, M.D.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 176.)

Mr. Wheelrr also made some determinations to compare the methods of double and single filtrations, with the following results:—

After weighing the precipitate of K_2PtCl_6 in a Gooch crucible, it was reduced in a low red-heat in a current of hydrogen, the potassium chloride washed out, and the resulting platinum weighed. The first column in the following Table shows the percentage of K_2O calculated from the double chloride, and the second the same from the platinum.

First method.—Addition of barium hydrate in slight excess, filtration, precipitation of excess of barium by ammonium carbonate, determination of potassium in filtrate.

	Per cent of K_2O.	Per cent of K_2O.
No. 1..	12·26	12·30
No. 2..	12·08	12·10
No. 3..	12·22	12·16
Mean.. ..	12·12	12·19

Second method.—Addition of barium hydrate, and then, before filtering, of ammonium carbonate, filtering and proceeding in the usual way.

	Per cent of K_2O.	Per cent of K_2O.
No. 1..	12·06	12·04
No. 2..	12·04	12·02
No. 3..	12·12	12·08
Mean.. ..	12·07	12·05

From the above it is seen that the error arising from a single filtration, as in the previous case, amounts to about 1 per cent. The percentage of potash calculated from the double salt is practically the same as from the platinum. Hence there appears to be no necessity for reducing the platinum in a current of hydrogen and a re-calculation of the results. Dr. Crampton, working by his first and second methods, already described, obtained the following results with the same sample that Mr. Wheeler used in the numbers just given. In the second column will also be found the results calculated from the reduced platinum.

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

	Per cent of K_2O.	Per cent of K_2O.
No. 1..	10·23	10·17
No. 2..	10·36	10·08
No. 3..	10·14	10·02
Mean.. ..	10·21	10·09

From the same sample Dr. Crampton obtained, using the Washington method, as a mean of four analyses, 10·92 per cent of K_2O.

The above results show that by reduction of the precipitated and hydrogen gas a reliable check on the accuracy of the analyses is obtained. But the numbers secured by reduction agree so closely with those got directly from the double chloride that for commercial purposes the additional work cannot be recommended.

The difference in the results obtained by the two experimenters above shows either the difficulty of getting even samples of the same fertiliser, or that the magnitude of the personal equation is greater in the estimation of potash than it is for most other substances.

There is one precaution that should always be taken in potash determinations, viz., not to have any ammoniacal fumes in the room during the evaporation after the addition of the platinic chloride.

Illustrating the effect produced by this cause, six determinations of potash in a fertiliser in a room free of ammonia, and four others made in a room in which other analysts were working on the estimation of phosphoric acid, are given. The ten determinations were all of the same sample and were made by one person, namely, Mr. G. L. Spencer. The sample was of the same fertiliser as the one used by Messrs. Crampton and Wheeler, as given above.

The per cent of K_2O determined in room free of ammonia is in first column, and from room containing ammonia in second column.

	Per cent.	Per cent.
No. 1..	3·03	3·17
No. 2..	2·91	3·85
No. 3..	2·94	3·65
No. 4..	2·99	3·64
No. 5..	2·93	0·00
No. 6..	3·07	0·00

From a study of the above results it does not appear that any advantage is obtained from the methods employed to shorten the time and diminish the labour of a potash determination.

Six samples of fertilisers containing potash were prepared by the Committee in as uniform a manner as possible, and were sent in sealed packages to the members of the Association.

Following is a description of the samples:—

No. 1. Commercial kainite.
No. 2. Commercial superphosphate.
No. 3. Commercial high-grade phosphate, with nitrate of potash.
No. 4. Tankage and potash.
No. 5. Tobacco-stems and ground bone.
No. 6. Ground bone and nitrate of potash.

Accompanying the samples the following circular letter was sent:—

Washington, D.C., July 2, 1885.

SIR,—In behalf of the Committee on Potash appointed by the Association of Official Agricultural Chemists at the Philadelphia meeting last September, I have sent you by express samples of fertilisers containing potash, numbered 1 to 6 respectively.

Will you determine in them water and potash by the method recommended by the Association, and also by the method usually employed by you, or by any other method you may desire to try? When the work is done please report results to me with detailed accounts of methods employed other than that recommended by the Association. The names of the Analysts are to be received by the Chairman of the Committee in strict confidence, and are not to be made known in connection with their results.

All the results received will, however, be tabulated and reported to each analyst contributing, that he may see how his work compares with that of other chemists. The greatest care has been taken to secure uniformity in the samples sent out. Inasmuch as the Association will meet again in Washington early in September, it is desired that you forward the results of your work as soon as possible.

Respectfully, H. W. WILEY,
Chairman Potash Committee.

Owing to the late date at which the samples were sent out, the Committee has not received as many returns as had been expected.

In all, returns have been received from four laboratories, containing the results of the independent work of eight chemists.

These returns have been collected in two Tables, the first of which gives the results of the analyses by the Philadelphia method, and the second by slight variations therefrom, explained in the subsequent notes.

Analyses of Samples of Commercial Fertilisers by Philadelphia Method.

Analyst.	(1) K_2O.	(2) K_2O.	(3) K_2O.	(4 K_2O.	(5) K_2O.	(6) K_2O
D ..	12·81	4·01	2·24	2·46	3·20	3·54
E ..	13·58	4·64	2·58	2·66	3·23	3·58
F ..	12·04	3·98	2·32	2·64	2·90	3·38
G ..	12·44	4·24	2·37	2·74	2·80	3·38
H ..	13·39	4·33	2·26	2·41	2·99	3·34
Mean	12·85	4·24	2·35	2·58	3·02	3·44

Determination of Potash in Committee's Samples.

Analyst.	(1) K_2O.	(2) K_2O.	(3) K_2O.	(4) K_2O.	(5) K_2O.	(6) K_2O
A ..	13·77	4·21	2·03	2·38	3·07	3·27
B ..	12·41	3·61	1·08	2 25	3·28	3·33
B' ..	12·03	3·45	1·76	2·27	3·23	3·47
C ..	14·24	4·23	2·48	2·29	3·55	3·59
F' ..	12·04	4·21	2·34	2·74	3·14	3·47
G' ..	12·80	4·47	2·54	2·61	2·90	3·38
Mean	12·55	4·03	2·14	2·41	3·39	3·42

Method A.

Ignite sample at low red-heat; exhaust residue with water, acidulated with hydrochloric acid; add barium hydrate; filter; precipitate excess of barium with ammonium carbonate; filter; evaporate; filtrate to dryness; ignite residue at low red-heat; exhaust with water; filter; precipitate with excess of platinic chloride, and proceed in the usual way.

Method B.

Take 2 grms. of sample, digest on steam-bath fifteen or twenty minutes with 25 c.c. of water, transfer to a filter, wash with successive small portions of hot water until filtrate and washings amount to 100 c.c. The filtrate is treated with saturated solution of barium hydrate in slight excess, heated, and filtered. To filtrate is added a little ammonium hydrate, and then ammonium carbonate in slight excess, precipitate filtered off and washed, and the filtrate and washings evaporated to dryness and ignited. The dry residue is treated with a little hot water, filtered, a little hydrochloric acid added, evaporated to a thick syrup, treated with 80 per cent alcohol, allowed to stand twelve hours, filtered through a Gooch crucible, dried at 105° to 110°, and weighed.

Method C.

Two grms. of sample boiled with 100 c.c. water, and washed with 200 c.c. water on a small filter. Precipitate hot with 35 c.c. saturated solution of barium hydrate, and

filter. Add lump of ammonium carbonate to filtrate, and heat until excess of carbonic acid has gone off. Filter off barium carbonate, add about ½ a grm. of oxalic acid, evaporate to dryness in platinum dish, and ignite at a low red-heat to destroy organic matter and nitrates. Filter on a 5-centimetre filter-paper into a 50 c.c. platinum dish, add 2 c.c. dilute hydrochloric acid, then excess of platinic chloride, and proceed according to Crookes's "Select Methods."

Methods F' *and* G'.

These methods were the same as the one adopted in Philadelphia, with the exception that an ordinary filter-paper was used instead of a Gooch crucible for collecting the precipitate.

After a careful consideration of all the results which have come to the notice of your Committee, we do not think that the general principles of estimating potash should be greatly changed from those given in the report at the Philadelphia meeting. We therefore beg to suggest, for the consideration of the convention and for adoption for the forthcoming year, the following—

Method for Estimating Potash.

In case the potash is contained in organic compounds like tobacco-stems, cotton-seed hulls, &c., it is to be saturated with strong sulphuric acid, and ignited in a muffle to destroy organic matter. Pulverise the fertiliser (200 or 300 grms.) in a mortar; take 10 grms., boil for ten minutes with 200 c.c. water, and, after cooling and without filtering, make up to 1000 c.c., and filter through a dry paper. If the sample have 10 to 15 per cent K_2O (kainite), take 25 c.c. of the filtrate; if from 2 to 3 per cent K_2O (ordinary potash fertilisers), take 100 c.c. of the filtrate. In each case make the volume up to 150 c.c., heat to 100°, and add, drop by drop, with constant stirring, slight excess of barium chloride; without filtering, in the same manner add barium hydrate in slight excess. Filter and wash until precipitate is free of chlorides. Add to filtrate 1 c.c. strong ammonium hydrate, and then, drop by drop, a saturated solution of ammonium carbonate until excess of barium is precipitated. Add now in fine powder 0·5 grm. pure oxalic acid, or 0·75 grm. ammonium oxalate. Filter, wash the porcelain dish free of chlorides, evaporate filtrate to dryness in a porcelain dish, and, holding dish with crucible tongs, ignite carefully over the free flame below red-heat until all volatile matter is driven off.

The residue is now digested with hot water, filtered through a 5-centimetre filter, and washed with successive portions of 2 c.c. water until the filtrate amounts to 30 c.c. To this filtrate, after adding 2 drops of strong hydrochloric acid, is added, in a porcelain dish, 10 c.c. of a solution of 10 grms. of platinic chloride in 100 c.c. of water. The mixture is now evaporated on the water-bath to a thick syrup, treated with 85 per cent alcohol, well rubbed with the stirring-rod, washed with 85 per cent alcohol by decantation, collected on a Gooch crucible, washed with 85 per cent alcohol, afterwards with 5 c.c. ether, dried for thirty minutes at 100°, and weighed. It is not necessary to check the results by washing out the precipitate and re-weighing the crucible, or by reducing its weight after washing out the potassium chloride. We recommend the continuance of the use of the factor 30·56 for converting K_2PtCl_6 to KCl, and 19·308 for converting to K_2O. We further recommend that the Committee on Potash which may be appointed for the coming year distribute at an early date samples of fertilisers to members of the Association and others interested, with such recommendations as may seem best suited to secure a thorough trial of this and all new methods which may appear to promise success.

Respectfully submitted. H. W. WILEY, Chairman.
W. J. GASCOYNE.
CLIFFORD RICHARDSON.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

April 10th, 1886.

Prof. BALFOUR STEWART, President, in the Chair.

THE following communications were read:—

"*On the Cause of the Solar-Diurnal Variations of Terrestrial Magnetism.*" By Prof. BALFOUR STEWART, LL.D., F.R.S.

The author commenced by reviewing various theories that have been advanced to account for the solar-diurnal inequalities of terrestrial magnetism. That they can be due to the direct magnetic action of the Sun is highly improbable, since terrestrial analogies would lead us to infer that matter at the temperature of the Sun is quite incapable of possessing magnetic properties, and also from the fact that changes in the range of the daily variation lag behind corresponding solar changes in point of time. The hypothesis of Faraday, that the observed variations are the result of the displacement of the magnetic lines of force due to the varying temperature, and consequently varying magnetic permeability, of the atmospheric oxygen, is disproved by the fact that there is no agreement between the chief magnetic variations and those of the temperature of the great mass of the atmosphere, though it is certain that there must be some effect due to this. The Earth-current hypothesis is quite unable to explain one of the chief characteristics of these variations, that they are half as great again at periods of maximum as at those of minimum sun-spot frequency: Sir George Airy has, moreover, been unable to detect any resemblance in form between the regular diurnal progress of the magnet and that of earth-currents. We seem, therefore, compelled to seek for the cause of the variations in the upper atmospheric regions, and we cannot imagine such a cause to exist in any other form than that of a system of electrical currents. That currents may, and actually do, exist at great heights is shown by the Aurora, which is unquestionably an electric current, and manifests a close connection with the phenomena of terrestrial magnetism. The great increase of magnetic variation at epochs of maximum sun-spot frequency can also be accounted for on this supposition. Prof. Stokes has remarked that an increase in the radiating power of the Sun would probably imply not only an increase in general radiation, but a special and predominant increase in such actinic rays as are probably absorbed in the upper regions of the Earth's atmosphere. These regions will therefore greedily absorb the new rays, their temperature will rise, and, as is known to be the case for gases, the electrical conductivity will be increased. Thus, even if we imagine the general atmospheric current to remain constant, a greater proportion of it would be thrown at such times into those heated portions which had become good conductors, but it is also probable that the current itself would be increased. Assuming the existence of currents at great altitudes, the regularity and general characteristics of the diurnal variations would seem to point to a direct magnetic action of the currents rather than to any general induced change in the magnetic system of the Earth, which, to produce the observed results, would have to be of a very artificial character. The diurnal variation of the declination, attaining a westerly maximum at 2 p.m., north of the Equator, and an easterly maximum at the same time south of it, would suggest the existence of currents flowing northward and southward from the Equator to the Poles, attaining a maximum in each hemisphere about two hours after the Sun had passed the meridian. To supply this flow we should probably have to assume the existence of vertical currents ascending from the equatorial regions of the Earth. At this point Dr. Schuster has endeavoured to apply mathematical analysis to the subject. From the

recorded observations at Greenwich, Lisbon, Hobarton, St. Helena, and the Cape, he has shown that the work done by a magnetic pole describing a closed path in a horizontal plane at those places is equal to the work done upon it, and consequently no part of the ascending current can be enclosed by the path. Hence the potential at those places obeys the law expressed by the equation—

$$\frac{d^2V}{dx^2} + \frac{d^2V}{dy^2} + \frac{d^2V}{dz^2} = o.$$

From this Dr. Schuster has deduced two possible expressions for the potential, one referring to a system of currents above our heads, and the other to one beneath our feet. From the first of these expressions it follows that, for latitudes greater than 45', the maximum of horizontal force should coincide with the minimum of vertical force, and *vice versa*, and this is actually the case at Greenwich; while the opposite should hold if the influencing system were beneath us. For latitudes below 45° the reverse of the above should be the case, and the observations at Bombay, though less decided than those at Greenwich, would seem to point the same way. On the whole, then, it must be said that the results of the first attempt are very encouraging, and point to the supposition that the greater part of the disturbing cause lies outside the Earth's surface.

In a discussion that followed, Mr. Whipple remarked that recent observations in high latitudes seem to show that the Aurora is not always at such a great height as is usually supposed.

Prof. A. W. Rücker cited the well-known case when an observer saw what appeared to be a meteor fall into the Sun, while simultaneously, or nearly so, there was recorded a magnetic disturbance on the Earth, as showing a direct solar action.

Mr. Whipple, however, stated that he had recently examined this point, and believed that the very slight notch in the record, many similar to which have occurred since, was of an accidental nature, and a mere coincidence.

Prof. McLeod suggested that the Earth-current theory might be tested by observations at the bottom of a mine, where, according to the theory, the disturbances should be reversed.

Prof. Adams believed that there was nothing physically impossible in the existence of such currents, as the author imagines.

"*On a Relation between the Critical Temperatures of Bodies, and their Thermal Expansions as Liquids.*" By Prof. A. W. Rücker, F.R.S., and Prof. T. E. Thorpe, Ph.D., F.R.S.

A paper by the authors, bearing the above title, was published in the *Journal of the Chemical Society* for April, 1884. The substance of the paper was as follows:—Prof. Mendelejeff has shown that that the expansion of liquids under constant pressure between 0° C. and their boiling-points may be expressed by means of the very simple formula—

$$V_t = \frac{1}{1 - k\,t},$$

V_t being the volume at t° C. (that at 0° being unity), and k a quantity which differs for different substances, but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling-point. From this law the authors have obtained as a deduction the following expression for the critical temperature (T_c) of any liquid—

$$T_c = \frac{T\,V_t - 273}{a\,(V_t - 1)},$$

where V_t is the volume at t° C., T the absolute temperature, and a a quantity which is very nearly constant for all substances, and which was shown to be very nearly 2.

In a recent paper (*Ann. Chem. Phys.*, March, 1886) MM. A. Bartoli and E. Stracciati have discussed both of these formulæ, and have applied them to cases in a manner never intended by the authors. They have expanded Mendelejeff's formula into the series—

$$V_t = 1 + k\,t + k^2\,t^2 + k^3\,t^3 \ldots .$$

which is a geometrical progression, and they have objected to it that the results of Piure, Kopp, Him, Thorpe, &c., do not give for the coefficients t, t^2, t^3 quantities in geometrical progression. The results of these observers are given in the usual form—

$$V_t = 1 + a\,t + b\,t^2 + c\,t^3, \ldots .$$

but, owing to unavoidable errors of experiment, the constants c d of different observers differ very largely, and Mendelejeff's simple expression gives the results of all qnite as accurately as the facts will allow. MM. Bartoli and Stracciati have then criticised the expression given by the authors, and have applied it to determine the critical temperature of water from its expansion to 200° C., whereas the original expression is only given as applicable as far as the boiling-point. They have further recorded a number of critical temperatures calculated by the formula to tenths of a degree, for which the constant a would require to be known to 0·025 per cent, whereas there is no reason for supposing it known to within 1 per cent or more.

NOTICES OF BOOKS.

A Short Manual of Chemistry. Vol. I. Inorganic Chemistry. By A. Dupré, Ph.D., F.R.S., and H. Wilson Hake, Ph.D., F.C.S. London: C. Griffin and Co.

This manual differs favourably from many of the elementary works on chemistry which have appeared in such alarming numbers. Though designated as "short" on the title-page, it does not carry brevity to such an extent as to render meagreness unavoidable. Again, we do not find the rarer elements ignored, as is too often the case. On the contrary, they are here described quite as fully as is compatible with the extent of our definite knowledge concerning them, and with the compass of the work. Lastly, there is no reference in the Preface to any "Syllabus" or to any contingent examination; nor is there as a tail-piece a list of questions set by any examining body.

In the second paragraph of the Preface we find an attempted explanation of the multiplicity of chemical manuals with which we cannot fully agree:—"We believe that the very multiplicity of text-books already published tends to show a want felt, but not yet satisfied." We can scarcely put so charitable a construction upon the appearance of a majority of the manuals and "manualettes" which it has been our duty to notice. Were their authors striving after some ideal in arrangement and exposition not yet realised, they would not, we think, have been cast so very decidedly in the same mould. This is, however, a very secondary consideration as far as the present work is concerned.

Drs. Dupré and Hake may fairly be congratulated on the eminently lucid character of their exposition of chemical truths. We notice also with pleasure that they do not, like too many authors, allow the student to go away with a belief in the absolute character of certain laws, such as those of Dulong and Petit, Neumann, &c., which after all are mere approximations, trustworthy within certain limits only.

In the chapter on the "Classification of the Elements" due credit is given to Mr. J. A. R. Newlands as the first discoverer of what is now known as the "periodic law."

On the subject of water-supplies the authors take the medical view rather than the purely chemical. Whilst admitting that any substance other than oxygen and hydrogen may be regarded as impurities, and that in con-

sequence all natural waters are more or less impure, they add the important qualification that—"Considered, however, in relation to its use for drinking and other domestic purposes, it is more or less misleading to call every such substance, dissolved or suspended, an impurity, but only such as are distinctly harmful should be regarded as such." Hence they would certainly not include, *e.g.*, the calcium carbonate contained in the Metropolitan water-supply among the "tons of impurities which Londoners contentedly swallow."

We notice that the authors repudiate the term "metalloids" still applied by certain foreign chemists to the non-metals, and they quote the suggestion of Prof. Tilden that this term should better be applied to a number of elements which occupy a somewhat doubtful place between the metals and the non-metals, being referred sometimes to the one and sometimes to the other of these classes.

The work before us may, in fine, be pronounced useful not merely as a text-book for the student, in the narrower sense of the term. Readers who may wish to acquire a general knowledge of chemistry, apart from any special or professional aims, will find this volume well suited to their purpose.

Rudiments of Chemistry. By TEMPLE ORME. London: Swan Sonnenschein, Le Bas, and Lowrey.

THE author of this little book tells us that his "object has been to explain the nature of chemical research and of scientific induction, in so far as that can be done by means of simple experiments and without the use of the Atomic Theory." Mr. Orme tells us further that he has tried his utmost not to introduce anything original into a book intended only for elementary instruction. He adds the remark, however, that in some cases "the teaching is very much at variance with that of popular text-books." One instance of this we notice with reference to the respiration of animals and of plants. After mentioning that carbonic acid is produced by the respiration of animals, he goes on to state that "plants also breathe, but the effect they have on the atmosphere is the exact opposite to that of animals." It is now considered that the true respiration of plants is analogous in its results to that of animals, whilst the process by which they decompose carbonic acid, fixing the carbon and setting free the oxygen, is a process of assimilation or nutrition.

The work contains a number of miscellaneous questions and examples, but there is no reference to preparing for any examination.

Experiments on Ensilage, conducted at Rothamsted, Season 1884-85. By Sir J. B. LAWES, LL.D., F.R.S., and J. H. GILBERT, LL.D., F.R.S.

THE following are the principal results of a prolonged series of experiments carefully performed by the authors. They find that it would require a larger area of land to obtain a given quantity of dry food-substance in crops grown for ensilaging than to obtain the same quantity in roots. The substitution of ensilage-crops for roots on a large scale would necessitate a considerable change in the course of cropping. It would lessen the area under cleaning crops, and consequently lessen the area suitable for growing grain for the market. Where ensilaging is only adopted instead of hay-making, it is improbable that it will be substituted for it entirely, and if only partially the process would only have a comparatively limited application. Or if it be extended to the natural and artificial grasses usually fed on the land, an expensive mode of feeding would be substituted for a natural one.

We may here remark that the inducement to abandon haymaking has become very small since the Gibbs drying machine enables the farmer to obtain excellent hay even in the worst weather.

In ensilage there is some total loss of nitrogenous matter; but there was a much larger amount of it degraded from the albumenoid condition to compounds incapable of forming the nitrogenous substances of animal increase or of milk. The results obtained do not favour the opinion that woody fibre of a given degree of induration is rendered more soluble, and consequently more digestible.

When analysed, the milk of cows fed on mangels invariably showed a higher percentage of both total solid matter and butter-fat than that of silage-fed cows. This fact proves that the diet of cows is not without an appreciable influence upon the composition of the milk. The authors, whilst thus declaring the ensilage milk poorer than that obtained from cows fed on roots, yet state that "quite consistently with the observations of others on the same point, the milk of our silage-fed cows was judged, both by colour and by taste to be richer than that of the mangel-fed cows." Here, therefore, we have evidence of the untrustworthiness of taste and colour as indications of quality.

This report, evidently drawn up with judicial impartiality, and based on careful experiments, will not be welcome to enthusiasts who entertain the wild and unchemical idea that "produce which is itself not good food can be made good food by being ensilaged."

Coca, Cocaine and its Salts: their History, Medical and Economic Uses, and Medicinal Preparations. By W. MARTINDALE, F.C.S. London: H. K. Lewis.

THIS work is in its tendency medical and pharmaceutical rather than chemical. We find no mention of any product found in the coca-leaves other than cocaine, hygrine, ecgonine, coca-tannin, and coca-wax. Cocaine does not appear to produce any well-characterised reactions. No colouration is produced on dissolving cocaine or its hydrochlorate in pure, cold, concentrated sulphuric acid. "Some samples of them" (apparently of the salts of cocaine) give a faint evanescent yellow colour, and others take a magenta tinge, which passes to a brownish yellow and fades away."

The effects of coca upon the human system are very contradictory. Von Tschudi and Pöppig give very doleful accounts of the intemperate use of coca by the inveterate *coqueros*. Weddell, on the contrary, who has more recently travelled in the districts where it is most in use, met with no results at all resembling those described by Pöppig. Even Von Tschudi admits that the moderate use of coca is not merely innoxious, but that it may even be very conducive to health. Its cultivation is even recommended as likely to be remunerative in Jamaica, Ceylon, India. But in consequence of the sensational reports which have been set abroad planters and merchants would very probably have to encounter one of those "Anti"-societies in which England is so fruitful, and which would doubtless by its emissaries denounce them as ministering to "a degrading vice."

The little work before us is printed in blue ink on a pale green paper. It is very probable that this arrangement would prove less fatiguing to the eye than the sharp contrast of black and white which is conventionally adopted.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 13, March 29, 1886.

Theory of Dynamo-Electric Machines acting as Recipients.—Giza Szarvadz.

Election of Perpetual Secretary for the Physical Sciences.—M. Vulpian has been elected in place of the late M. Jamin after an obstinate contest.

An Absolute Electrometer with Continuous Indications.—E. Bichat and R. Blondlot.—These two papers require the accompanying diagrams and illustration.

Combinations of Vanadic Acid with the Oxygen-Acids.—A. Ditte.—Vanadic acid forms definite compounds with certain oxygen acids, some of which can be isolated in the free state in the crystalline form, whilst others have as yet only been obtained in the form of salts. The author describes here the former class, the compounds formed with sulphuric, phosphoric, arsenic, iodic, and molybdic acids. The compounds formed with tungstic, silicic, oxalic, and tartaric acids belong to the second class.

Action of Platinum at a Red Heat upon Phosphorous Fluorides.—H. Moissan.—Not merely the phosphorus but also the fluorine appear to be fixed by the platinum. Platinum-sponge which has been thus treated is heavy, in part melted, and if treated with sulphuric acid in a lead vessel covered with a plate of glass hydrofluoric acid is liberated.

Splitting up of Compounds optically inactive by Compensation.—E. Bichat.—The author maintains that the experiments of MM. Scacchi and Wyrouboff (*Comptes Rendus*, Feb. 22) merely prove that the splitting up of sodium-ammonium racemate is possible merely between certain temperatures. He finds that the fission takes place only when the solution is exposed at a sufficiently low temperature to the temperature of atmospheric dust.

A Photo-chemical Reaction of Schützenberger's Oxymetric Action.—Victor Jodin.—In a former communication (*Comptes Rendus*, cii., 264) the author laid before the Academy some older experiments the conclusion from which was that light, outside of physiological conditions, produces in chlorophyll oxidising actions very different from the reducive reaction which characterises the *chlorophyllic act, i.e.*, the decomposition of carbonic anhydride. The recent observations of M. Regnard seem, on the contrary, to show that chlorophyll isolated from the living cell may still act upon carbonic acid and effect its decomposition in light. The author has therefore repeated the experiments of M. Regnard, and whilst verifying their accuracy has detected a fact which has vitiated the interpretation of these observations. The principle of Regnard's method was to bring in contact with Schützenberger's reagent (oxymetric liquor), *i.e.*, Coupier's blue decolourised by hydrosulphite, the different preparations of chlorophyll, where the question was to establish the emission of oxygen on exposure to light. But Jodin finds that the reagent of itself has the property of turning blue, that is, of giving the reaction of oxygen on mere exposure to light. His experiments seem to demonstrate that the oxymetric reagent is of itself susceptible to light, and that this property should be taken into consideration when it is necessary to show a photo-chemical reaction accompanied by a liberation of oxygen.

Volatility of Oxygenous Nitriles.—L. Henry.—The proximity of oxygen and nitrogen, both entirely fixed upon carbon and forming a system CN—CO, determines a special volatility in the compounds which contain it and distinctly reduces their boiling-point.

Effluviography.—Boudet de Pàris.—With reference to the communication of M. Tommasi inserted in the *Comptes Rendus* for March 22 (vol. cii., p. 677), entitled "Effluviography, or obtaining an Image by the Effluve," the author informs the Academy that these same results were brought forward by himself on March 3rd at the Public Session of the International Society of Electricians. The text of this communication was published in full, with a reproduction of the figures in *La Lumière Electrique* for March 20.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxii., Part 1.

On Certain Ethers of Hypophosphoric Acid, and on a New Method for its Production.—Dr. A. Sänger.—The author treats of the action of ethyl-iodide upon silver hypophosphate at 100°, at the ordinary temperature of dwelling-rooms, and in presence of anhydrous ether. He then describes the hyperphosphoric ethyl-, methyl-, propyl-, butyl-, and amyl-ethers, and the formation of hypophosphoric acid by the action of silver nitrate upon phosphorous acid. He determines the quantity of ammonia necessary for dissolving silver hypophosphate, describes silver phosphite and the crystalline hydrate of hypophosphoric acid, and its decomposition. In an Appendix he describes an unsuccessful attempt to prepare a penta-hydroxyl-phosphoric acid.

On Bromo-pyromucic Acids.—H. B. Hill and C. R. Sanger.—A memoir read before the American Academy of Arts and Sciences, November 12th, 1884.

Speed of Saponification.—L. Th. Reicher.—This memoir, which is a continuation of one inserted in *Annalen* (ccxxviii., p. 257), does not admit of useful abstraction, the results being given in the form of tables.

On Hypophosphoric Acid (Fourth Treatise).—Theodor Salzer.—An account of neutral magnesium hypophosphate (dimagnesium subphosphate), mono-magnesium subphosphate (acid magnesium hypophosphate), ammonium-magnesium hypophosphate, acid calcium hypophosphate, and neutral silver hypophosphate.

Indeterminate Equations used by Pebal in his Examination of Euchlorine.—L. Boltzmann.—The author holds that, on the assumptions laid down, euchlorine must be a mixture of three gases, one of which is ordinary chlorine, the second hypochloric acid, and the molecule of the third would have to consist of four atoms of oxygen, just as the molecule of ozone consists of three.

On Calculating the Observations made with Bunsen's Ice-Calorimeter—L. Boltzmann.—A mathematical paper, incapable of abridgment.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 5, March 1, 1886.

Assay of Commercial Oxygenated Water.—A. Riche.—This paper requires the accompanying illustration.

Detection of Sulpho-conjugated Magenta and of Ordinary Magenta in Wines by means of Metallic Oxides.—P. Cazeneuve.—Noticed under the *Comptes Rendus*, in which it first appeared.

Properties of Magenta.—M. Frehse.—Already noticed.

Communication on the New Mexican Pharmacopœia.—M. Dreyer.—The only chemical facts mentioned in this memoir is the existence of pipitzahoic acid, obtained from the root of *Dumerilia alamani*, an indigenous plant belonging to the order of Compositæ; and an alkaloid erythro coralloidine, discovered by S. Rio de la Loza in the seeds of *Erythrina coralloides*, remarkable as being the only poisonous principle as yet obtained from a leguminous plant.

Action of Boric Acid and of Borax in the Human Organism, and on its Elimination.—Dr. Johanson.—Except a considerably increased diuresis, the ingestion of boric acid had generally little action. In one case only symptoms of poisoning appeared after 3·6 grms. had been taken. After the cessation of its use the reaction of boric acid was still recognised in the urine for eight days, and in one case for fifteen days.

Detection of Ergotised Rye in Flour.—M. Hilger.—Ten grms. of the flour are left in contact with 20 grms. of ether and 10 drops of dilute sulphuric acid (1 : 5) for

some hours, at an ordinary temperature, in a well-stoppered flask, with frequent agitation. The filtrate is made up to 20 c.c. with the ether which has served for washing the mass, and ten to fifteen drops of a solution of sodium carbonate, saturated in the cold, are then added. The mixture is shaken up; the colouring matter dissolves in the watery liquid, to which it gives a violet or reddish violet colour. Still better results are produced when the flour is first moistened with a few drops of a 20 per cent solution of caustic potassa. After about ten minutes we then proceed to the treatment with ether, increasing the quantity of sulphuric acid in proportion to the alkali. The farina may then be examined with the microscope, saccharifying the starch of the flour previously with extract of malt.

Moniteur Scientifique, Quesneville.
3rd Series. Vol. xvi., March, 1886.

Alkaloids derived from the Bacterian or Physiological Destruction of the Animal Tissues.—Armand Gauthier.—In this extensive memoir, read before the Academy of Medicine, the author, after a historical survey, considers first the extraction of the septic alkaloids or ptomaines, the properties and nature of the ptomaines at present known, among which we find particular mention of parvoline, hydrocollidine and collidine, neuridine, cadaverine, putrescine, saprine, and mydaline. Cadaverine, putrescine, and saprine are not poisonous. Mydaleine is a very poisonous diamine. The putrefaction of fishes yields a poison having the same composition and the same action as muscarine. Putrid cheese yields neuridine. The bacillus to which Eberth attributes typhoid fever does not produce putrefaction, but in the liquids where it has lived there is found a trace of a base which dilates the pupils, brings on diarrhœa, and proves rapidly fatal. The physiological action of these bases and their chemical action are very carefully studied. The second portion of the treatise is devoted to the physiological alkaloids or leucomaines.

The Whole Duty of the Chemist.—From *Nature*.

The Complete Duty of the Chemist.—From *Nature*, being Dr. Odling's reply to the foregoing paper.

The Institute of Chemistry.—E. Frankland.—From the Chemical News. To this paper are appended a number of letters on the subject of the Institute of Chemistry, reproduced from the Chemical News.

International Exhibition of Inventions in London.—Watson Smith.—From the *Journal of the Society of Chemical Industry*.

The Artificial Colouring-Matters applied in Industry.—A continuation of a course of six lectures delivered by Prof. Noelting at the School of Chemistry at Mulhouse.

Industrial Society of Mulhouse.—Sittings of Dec. 9, 1885.—M. Binder communicated some observations as regards the reducing and oxidising agents of the aromatic series, taking phenyl hydrazine as an instance of the former and phenylene dichlorodiimide of the latter.

Prof. Noelting communicated various researches effected in the laboratory of the Chemical School.

Sitting of Jan. 13, 1886.

M. Hofmann requested information as to the procedures used in Alsace for purifying the waste waters of dye-works. M. Briethaupt sent in a prospectus of a new antiseptic, borhydrine.

M. Rettig sent in the completion of his researches on the action of manganese bronze upon a certain number of aromatic bases.

Camille Kœchlin, in a letter to the editor, mentions that murexide, like aniline black, is affected by sulphurous acid, but is incapable of restoration to its original shade.

C. Kœchlin mentioned M. Knapp's research on the development of ultramarine in the wet way, and stated that this colour is not destroyed by concentrated sulphuric acid. He also pointed out that all organic blue colouring-matters are nitrogenous, and suggested its necessity as a component of such dyes.

M. Weber described experiments showing that antimony oxalate and oxide when recently precipitated are excellent agents for fixing tannin.

German Review.—Under this head are inserted a number of abstracts from the *Berichte*.

Patents taken in France having connection with the Chemical Arts.—A list of titles of patents for November last.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 2, February, 1886.

Report delivered by Aimé Girard on behalf of the Committee of Chemical Arts on the Process of M. Delattre for Purifying the Waters which have served for Washing Wools.—Raw wools undergo two successive operations, the removal of the suint and scouring. The former of these operations, a simple steep in water, frees the wool from the more soluble part of the suint. The second process, which is performed with lyes of soap and soda crystals, removes the insoluble portion of the adhering grease and the various impurities which this grease has fixed and retains in adhesion to the textile fibre. These washing and scouring waters are very impure, and have occasioned much trouble both to manufacturers and to the municipal authorities. J. Delattre and Son convey the washing waters into a deep narrow cistern, where they deposit the sand which they contain. This sand is said to furnish an excellent manure, very rich in potash and in nitrogen. The water is then treated either with hydrochloric acid, ferric chloride, or manganese chloride to effect the separation of the fatty matters, which form a cake on the surface. After removing the fats the water is mixed with milk of lime, and is then allowed to rest so that the suspended calcareous matters may settle. From these tanks the water issues limpid, alkaline (!), and of a pale amber colour. A plan and section of the apparatus are given.

Supplementary Note on Apparatus for Elevating Corrosive Liquids.—M. River.—This paper consists of illustrations with their description.

MEETINGS FOR THE WEEK.

Monday, 19th.—Medical, 8.30.
Tuesday, 20th.—Institution of Civil Engineers, 8.
——— Pathological, 8.30.
Wednesday, 21st.—Geological, 8.
——— Meteorological, 7.
Friday, 23rd.—Quekett Club, 8.

Aniline Works, Clayton, Manchester, All newly erected, brick and slated. Eligibly situated, water free from the canal.—To be sold or let with or without the plant on very low and easy terms (a quantity of vacant land adjoining), cheap.—Address, S. Charlton, 10, Marsden Street, Manchester.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1378.

ON A NEW FORM OF STEREOSCOPE.*

By A. STROH.

Although the late Sir Charles Wheatstone's beautiful invention, the stereoscope, gives the appearance of full relief or perfect solidity to photographs of objects seen by its aid, the photographs for the same must naturally be of limited dimensions, and though viewed through magnifying lenses, the images of the objects are presented to the eye on a scale far below the size of their originals.

It has therefore occurred to me, that if the magnified image of a photograph projected on a screen by the optical lantern could be made stereoscopic, a still greater resemblance to the original might be obtained.

With a view of producing such an effect, I have constructed the apparatus I will now describe, which is, however, not intended to enable a large number of persons to see the projected pictures at the same time, as in the case of dissolving views, but is at present limited to the use of two persons simultaneously. It could, however, be easily constructed so as to be available for a greater number.

The principle of the arrangement depends on the well-known effects of the persistence of vision; revolving disks are employed for alternately obscuring two pictures, projected on a screen in the same place, and at the same time interfering with the view of the observer in such a manner that only one picture is seen by the observers' right eyes, and the other by the left eyes.

Two optical lanterns are placed side by side, as for dissolving views. Two transparencies, photographed in the same manner, as if intended for an ordinary stereoscope, are placed one in each lantern, and projected on a screen in such a position that they overlap each other as nearly as possible. The picture which is intended to be seen by the right eye may be placed in the right hand lantern, and the other in the left.

Supported by suitable framework, and in the front of the two lenses of the lanterns, is a revolving disk, portions of which are cut away, so that during its revolutions it obscures the light of each lantern alternately, or, in other words, so that only one picture at a time is thrown on the screen. A continuous change from one picture to the other is thus obtained.

In the same framework, and in convenient positions for the observers, two pairs of eye holes are provided, one pair on either side of the apparatus. Behind each pair is also a rotating disk, and these disks are connected by suitable wheel-work or driving bands with the one previously mentioned, in such a way that the three disks rotate together, and at the same rate. The two last-named disks are also so cut that they will obstruct the view through the right and the left eye-holes alternately.

Finally the connection between the three disks has to be so arranged that the time of obscuring the view of the observers' right eyes or left eyes shall coincide with the time when the light is shut off from the right or left lens of the lanterns respectively.

It is obvious that by this arrangement the left eyes can only see the picture projected from the left hand lantern, and the right eyes can only see that from the right hand lantern.

The rotation of the disks must be of such a rate that the alternate flashes of the right and left pictures on the corresponding eyes follow in such rapid succession that the impression made by one flash does not diminish sensibly before the next flash on the same eye is received. The number of flashes for each eye which is required to produce an apparently continuous view, without any flickering effect, is from thirty to forty per second. As the disks are so cut as to produce two flashes for the right eyes, and two for the left in one revolution, they must consequently be kept rotating at a rate of from fifteen to twenty revolutions per second.

The rotation of the disks is effected by a driving-wheel and band, worked by a crank handle at the back of the apparatus.

The perspective effect obtained by the above arrangement is very perfect, the image of each object standing out in solid relief.

Considering that by this arrangement the two eyes never see at the same time, and that each eye views its picture after the other, it is interesting to find that the persistence of vision so completely bridges over the alternate interruptions to which it is subjected as to produce the effect of a continuous view.

An unavoidable effect resulting from this arrangement is, that by the rotation of the disks one half of the light produced by each lantern is always cut off, the higher, therefore, the illuminating power used the better is the result.

This defect is, however, I consider, counter-balanced by several advantages which this form of stereoscope possesses. Firstly, the pictures can be enlarged to such such an extent as to appear equal, or even larger than the original objects from which they were taken; and secondly, the eyes, in looking at the pictures, are not in any way subjected to strain by lenses, prisms, or reflectors, or by the difficulty which some persons experience in getting the two pictures to superpose. For each eye views its corresponding picture in exactly the same position it would see it in if it were looking at the original, since the two pictures are practically in the same place, which is not the case in any other form of stereoscope.

Although with the apparatus as here described only two persons can see the pictures at the same time, it would not be very difficult to construct it so as to be available for a greater number. The side disks above described only serve to control one pair of eye-holes each, but by making them a little larger they would serve for two pairs each, thus accommodating four observers. By increasing the number of disks, the number of observers might be increased proportionately.

* A Paper read before the Royal Society, April 1, 1886.

ON A NEW METHOD OF DETECTING BROMIDES: A CASE OF SO-CALLED "CATALYTIC ACTION."*

By H. J. H. FENTON, M.A., F.C.S., F.I.C.,
Demonstrator of Chemistry in the University of Cambridge.

In former papers it has been shown that sodium carbamate is unacted upon by sodium hypochlorite in presence of sodium hydroxide, whereas sodium hypobromite immediately decomposes it with evolution of nitrogen.

$$2CO.NH_2.ONa + 3NaBrO + 2NaOH = 2CO(ONa)_2 + 3NaBr + 3OH_2 + N_2.$$

Carbamates differ in this respect from all other substances yet studied, and the action serves to detect and estimate them in presence of urea, ammonia, &c.†

On adding a soluble bromide to a solution of sodium carbamate, mixed with sodium hypochlorite and hydroxide, nitrogen is evolved. If this is due to the intermediate formation of a hypobromite,‡ it was to be expected that the total amount of decomposition would be independent

* The substance of a Paper read before the Cambridge Philosophical Society, March, 1886.

† Royal Society, December, 1885.

‡ Lyons, *Pharmaceutical Record*, May, 1885.

of the mass of bromide, within wide limits, since the bromide would be reproduced in the action. This I find to be the case. Thus 0·3854 grm. of potassium bromide readily caused the evolution of 340 c.c. of nitrogen from the above mixture, and the residual solution was still strongly "active,"—*i. e.*, caused an evolution of nitrogen from fresh portions of the mixture. This quantity of bromide in the form of hypobromite could only have caused an evolution of 24 c.c. nitrogen.

The initial *rate* of decomposition, however, appears to be a function of the mass of bromide present. A preliminary experiment in this direction was made as follows:—5 c.c., 10 c.c., and 20 c.c. of a solution of potassium bromide were taken in separate tubes, and made up to the same total volume with water. The tubes were placed respectively in three vessels (A, B, C), each containing the same volume of a mixture of sodium carbamate, sodium hypochlorite in excess, and sodium hydroxide. These vessels were fitted with stoppers and delivery tubes, and the evolved nitrogen collected and measured in the ordinary way.*

The masses of bromide were therefore—

$$A : B : C :: 1 : 2 : 4,$$

those of the other substances being the same in each case. The actions were started almost simultaneously, and the evolved nitrogen read off at stated intervals.

	After 3 minutes.	6 minutes.	10 minutes.	Abt. 30 m.
A gave	10 c.c. N	40 c.c.	51 c.c.	67 c.c.
B „	39	51	57	68·5
C „	55	59	62	68

Showing that the action is, in the first instance, more rapid as the mass of bromide is greater, but that the weaker solution afterwards gains on it, and all eventually give the same final result.

This action of bromides appears therefore to belong to the type of certain so-called Catalytic actions, in which the activity of the agent is explained by an intermediate stage of little stability.

By means of this action it is easy to detect bromides in presence of unlimited quantities of chlorides, hypochlorites, &c. A solution of sodium carbamate is mixed with excess of sodium hypochlorite and caustic soda, and shaken until bubbles of nitrogen (due to traces of ammonia) cease to be evolved. The addition of a soluble bromide to this mixture will cause an evolution of gas immediately if the quantity of bromide is considerable, and more slowly with dilute solutions. When traces only of bromide have to be looked for, it is advisable to make a blank comparative test, since the slight decomposition of the carbamate solution might be misleading.

Two equal volumes of the above test solution are placed in long tubes, the suspected liquid added to one, and an equal volume of distilled water to the other. The tubes are shaken and set aside for some time (ten minutes to one hour, according to quantity of bromide). On again shaking there will be an almost inappreciable evolution of gas only from the tube containing the blank test, whilst, if bromide is present, there will be a rapid effervescence in the other. In this way it is quite easy to detect 1 part of bromine in 6000 parts of water; probably much smaller quantities would be apparent.

Iodides appear to give a slight action, but so slowly that it seems not improbably due to traces of bromide as impurity. I have not, however, succeeded in obtaining a specimen of iodide which gives no action at all.

I find that a solution of sodium carbamate may be conveniently prepared by dissolving ammonium carbamate in a strong solution of caustic soda, and allowing the mixture to stand over strong sulphuric acid under a bell-jar for one or two days:—

$$CO.NH_2.ONH_4 + NaOH = CO.NH_2.ONa + H_2O + NH_3.$$

Also, by treating ammonium carbamate with sodium hypochlorite and caustic soda,—

$$2CO.NH_2.ONH_4 + 3NaClO + 2NaOH = 2CO.NH_2.ONa + 3NaCl + 5OH_2 + N_2.$$

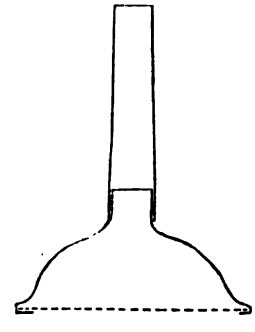
Or it may be prepared by Drechsel's method,—*i. e.*, by adding an alcoholic solution of sodium ethylate to ammonium carbamate dissolved in aqueous ammonia.

* *Chem. Soc. Journ.*, July, 1887.

A PLATINUM FILTERING BULB FOR DR. CARMICHAEL'S SYSTEM OF FILTRATION.

By P. CASAMAJOR.

Dr. Carmichael's system of filtration, first published, I believe, in 1870, is well known to all chemists. In this system filtration takes place on a small paper disc, held by the suction of a filter-pump against the flat perforated surface of a small vessel called a filtering bulb. A description of this system of filtration is given in Crookes's "Select Methods of Chemical Analysis" (London, 1886, p. 655). Chemists who have seen Dr. Carmichael perforate the flat surface of his filtering bulb by means of a hot wire say that the operation seems an easy one, but I have learned that very expert glass-blowers in New York have failed to make these perforations, so that many chemists, who would have liked to try these filtering bulbs, were not able to obtain them. Several years ago I tried Dr. Carmichael's plan very successfully, by making the filtering bulbs in two pieces, one of glass, having the shape of a Plattner's blowpipe mouthpiece, the other being a perforated platinum plate over which was placed a paper disc of slightly larger diameter. The paper disc and perforated plate were held against the glass portion by the suction



of a filter-pump. This apparatus was described in 1875 (Chemical News, vol. xxxii., p. 46; *American Chemist*, vol. v., p. 440).

In 1881 I published a description of another apparatus for Dr. Carmichael's system of filtration (*Journ. Am. Chem. Soc.*, vol. iii., p. 125).

Prof. J. P. Cooke, of Harvard, has made Dr. Carmichael's filtering bulb entirely of platinum (*Proceedings of the American Academy of Science and Art*, iv., n.s., 125). This seems the most practical and convenient way of making a filtering bulb; the shape is copied exactly from that of Dr. Carmichael's glass bulb. Only by such skill as a regular manufacturer of platinum ware possesses can Prof. Cooke's platinum bulb be made. Those he uses were made by Messrs. Johnson and Matthey, of London.

Some time ago I decided to try a Carmichael filtering bulb made entirely of platinum, and I succeeded in making it in such a way that any moderately skilful metal-spinner could construct one.

The figure represents, in section, this filtering bulb, which has given entire satisfaction. It is formed in three portions, the upper one being a straight tube, which is placed in communication with a filter-pump or its equi-

valent. This tube may be made entirely of platinum, or of platinum foil turned to form a tube, the edges of the foil being soldered with gold.

The portion immediately below this tube has the shape shown in section. No metal-spinner of ordinary skill could have any difficulty in turning it on a lathe. The platinum plate should have a thickness of not less than half a millimetre, or one-fiftieth of an inch. A flat shoulder is turned on the lower part of the bulb. Against this is placed the third portion, a perforated plate, and then the outer rim is turned over the plate so as to leave a circular margin of about 2 or 3 m.m. wide. The platinum bulb has a short tube, spun on the lathe, which is made conical so as to fit tightly into the tube which connects it with the aspirator. The bulb and tube may be soldered together with gold, if it is thought preferable, instead of being connected by the conical tube of the bulb fitting tightly into the longer tube.

The platinum filtering bulb which I am now using was made by Messrs Eimer and Amend, Third Avenue and 18th Street, New York.

ON THE DETERMINATION OF CHROME.

By H. VIGNAL.

THE gravimetric methods for separating and determining chrome are tedious, and require much care, whilst the volumetric determination of chromic acid by means of ferrous salts is expeditious in execution, and gives very exact results. The principle of this method, which has been known for some time, consists in adding to the solution of the chromic acid a known excess of iron in the ferrous state, and of determining, by means of potassium permanganate, the quantity of iron which the chromic acid has not peroxidised. The formula of the reaction shows that 6 equivalents of iron, or 168 parts, are peroxidised by 2 equivalents of chromic acid containing 2 equivalents of metallic chromium,—*i. e.*, 52·56 parts. If P represents the weight of iron peroxidised by a given solution of chromic acid, the weight of the chrome contained in this solution will be—

$$P \times 0{\cdot}313 = P \times \frac{52{\cdot}56}{168}.$$

If we determine ferrous oxide in the green solution of chromium sesquioxide, the first drop of permanganate in excess gives a dirty green tint, which should not be exceeded, for the weight of the chrome would thus be made to appear deficient. The analyst should accustom himself to catch this tint, taking for the purpose known volumes of a solution of potassium bichromate which has been determined with great accuracy gravimetrically.

We are generally apt to overstep the point of saturation a little; the error thus resulting is very trifling, but it may be corrected by substituting for the theoretic coefficient 0·313) another practical value depending on the eye of each operator. Thus, by taking 0·315 instead of 0·313, the author obtains, in known volumes of a solution of potassium bichromate, results quite accordant with those obtained gravimetrically.

To determine chromium in ores and in manufactured products it must be obtained as chromic acid in a solution free from nitrous acid, from free chlorine, and from any substance having an action upon ferrous salts. Chromium oxide in solution is more or less completely converted into chromic acid by certain oxidisers, such as lead and manganese peroxides and potassium chlorate. The latter evolves chlorine, and the liquid obtained cannot therefore serve for the direct determination of chromium.

With lead and manganese peroxides the conversion is incomplete if the proportion of chrome is somewhat high. On the contrary, when chromium oxide occurs in a strong boiling nitric or sulphuric solution, it is entirely converted into chromic acid by potassium permanganate, added either in crystals or in a strong solution. If potassium permanganate is added gradually to a solution of chrome kept very hot, this solution, if held over a white paper, appears to turn gradually from a deep yellow to a light yellow; the precipitate of manganese formed in the parts which the reagent reaches re-dissolves, either on stirring the liquid or on heating afresh, so long as the chrome is not entirely brought into the state of chromic acid; the potassium permanganate is finally converted into manganous oxide. But when all the chrome is peroxidised the first portions of permanganate in excess coming in contact with the manganous salt first formed constitute with it a higher oxide, which renders the liquid turbid, and which, after boiling for three or four minutes, collects in the form of precipitated peroxide. Instead of adding the permanganate gradually it may be introduced at once in sufficient quantity, and boiled for some minutes: in both cases the liquid contains all the chrome in the state of chromic acid, with a more or less abundant precipitate of manganese dioxide. After filtering the solution of chromic acid may then be titrated with a ferrous salt.

It may happen, especially in the case of products poor in chrome, that the permanganate is present in very large excess as compared with the chrome,—*i. e.*, after the peroxidation of the chrome, and the re-precipitation of all the manganous salt first formed in the state of manganese peroxide, there still remains in the liquid a certain quantity of permanganate. Ebullition decomposes this excess of the reagent, and precipitates it in the state of peroxide, and in this case, as in the former, the ultimate liquid contains all the chromic acid with the precipitate of manganese peroxide.

In filtering this liquid we may use either asbestos or paper. Paper filters more rapidly, but it requires certain precautions. To avoid the reduction of the chromic acid by the organic matter of the paper, it is well to moisten the filter first with hot water containing nitric acid. It is further advisable not to filter the liquid until it is quite cold and has been considerably diluted with water. If the precipitate has been obtained in a nitric solution it is flocky and filters well, but if in a sulphuric solution it is very fine and filters very badly.

In the analysis of chrome steels we have nitric liquids. For chromated cast-iron we are obliged to use sulphuric acid, but as soon as the metal is dissolved we may always add to the liquid so much nitric acid that the precipitate of manganese peroxide takes a distinct form. The precipitate is washed on the filter at first with cold and then with boiling water, until the last washings run through colourless. The washing is the more quickly completed the less bulky is the precipitate: this is why it is important to use only such a quantity of permanganate as is exactly sufficient to cause the precipitate.

The chromic solution filtered is free from nitrous products, from free chlorine, and from chlorides. It contains, indeed, nitric acid in a dilute state and colourless iron nitrate. It is mixed with a little sulphuric acid if there is none already present, and the chromic acid may then be very accurately determined with a ferrous salt. If we take known quantities of potassium bichromate, reduce it with sulphurous acid, and boil it in presence of an excess of nitric acid, observing the precautions indicated above for the addition of the permanganate and the filtration of the precipitate, the quantities of chromic acid found in the final liquid are exactly those taken.

It is seen that permanganate produces two distinct reactions: at first peroxidation of the chrome and formation of a manganous salt, and then re-oxidation of the manganous oxide and precipitation of the peroxide. Theoretically, 1·81 grms. of pure crystalline permanganate should suffice to peroxidise 1 grm. of chrome. The appearance of the precipitate indicates that the quantity of permanganate employed up to this moment is sufficient, and enables us to conclude approximately the quantity of

chrome contained in the liquid. For this purpose the permanganate is employed in the form of a strong solution, and is poured, drop by drop, from a graduated burette into the boiling liquid. The point of saturation is reached as soon as a slight brown precipitate is formed, which redissolves neither on stirring nor on boiling. The precipitate is easily recognised in the transparent liquid if the beaker is held above a piece of white paper.

It may be foreseen that this method is applicable only to products containing more than 2 to 3 per cent of chrome, and that, further, the results are always too high. In order that the precipitate of manganese peroxide may be formed in a very distinct manner, a certain excess of permanganate must always be present. To ascertain what degree of approximation may be reached by this means the author took cast-irons containing a known proportion of chrome, and used a solution of permanganate containing 18·1 grms. of the salt per litre. One c.c. of this solution should represent 1 c.grm. of chrome. For cast-irons in which the proportion ranged from 3 to 30 per cent, the mean error in excess was one-tenth of the chrome to be determined. In practice this error may be corrected either by multiplying the result by 0·90, or by using a solution of permanganante containing 20 grms. per litre.

This process, therefore, only gives approximate results; still it may be useful when it is required to follow the manufacture of chrome-irons step by step. With a little practice we may arrive at an approximation of ½ per cent.

Thus when a product can be directly dissolved in sulphuric or in nitric acid, the determination of the chrome may be effected expeditiously. Such products are chrome steels and the blast-furnace slags from the manufacture of ferro-chrome, which dissolve in nitric acid at 22° (B. ?), and, on the other hand, chromated cast-irons and ferro-chromes, which sulphuric acid dissolves very well.

The following is the course of operations for a steel:—1 grm. is dissolved in nitric acid at 22°, and 2 c grms. of permanganate are added to the hot liquid, or else 1 c.c. of the solution at 20 grms. per litre. This quantity is sufficient if the proportion of chrome is less than 1 per cent. The whole is boiled for three or four minutes; the solution is then let cool, diluted, and filtered.

For a slag the series of operations is the same. After dissolving it in nitric acid the quantity of permanganate which is judged sufficient, according to the probable amount of chrome, is added at the rate of 2 c.grms. per unit per cent. In filtering the precipitate, which is mixed with gelatinous silica, it is well to proceed by decantation.

The chrome-irons and ferro-chromes are not attacked by nitric acid. They dissolve, on the other hand, in less than an hour in sulphuric acid diluted with 3 volumes of water; ½ a grm. is dissolved at a gentle boil in 15 c.c. of water and 5 c.c. of sulphuric acid. When the reaction is over we add cautiously 25 to 30 c.c. of nitric acid at 36°, boiling for a moment to complete the peroxidation of the iron and to expel nitrous vapours; the permanganate is then added, either in solution or in crystals. If we use the solution at 20 grms. per litre we obtain at once the approximate percentage. To obtain an exact result it is necessary to filter and to determine the chromic acid in the liquid with a ferrous salt.

The chief difficulty in the analysis of chrome ores lies in the slowness with which they are opened up by chemical agents. Most commonly they are fused with caustic potash and potassium nitrate in a silver crucible, or with sodium carbonate and potassium nitrate in a platinum crucible. The latter method gives the better results, but care must be taken not to use too large proportions of alkalies, since the mixture flows like water, and the ore, falling to the bottom, is attacked very imperfectly. An intimate mixture is made of 1 part of the ore in very fine powder, with 1 part sodium carbonate and 1 part potassium nitrate, both finely ground. The mixture introduced into a platinum crucible should only occupy a small part of its bulk. The crucible is introduced into a muffle heated to redness, taking care to place it upon a cold potsherd so that it may not be heated too suddenly, and it is then left for an hour. The melted mass is taken up in water; the soluble portion contains merely chrome in the state of chromic acid, and is determined with a ferrous salt. The insoluble portion contains all the silica, alumina, and the other matters which constitute the ore. This portion, dissolved in hydrochloric acid, is treated like the hydrochloric solution of an ordinary iron-ore. It is easy to discover in this hydrochloric solution any particles of ore not opened up, and to separate these particles by decantation, either in order to weigh them or to submit them to a new attack.—*Bull. de la Soc. Chim. de Paris*, xlv., 171.

ON THE

SEPARATION AND DETERMINATION OF COPPER, CADMIUM, ZINC, NICKEL, COBALT, MANGANESE, AND IRON.

By AD. CARNOT.

AFTER having shown how, by means of ammonium or sodium hyposulphate, we may separate copper from cadmium, and the latter from zinc, the author indicates in what manner he effects the separation of zinc, nickel, and cobalt, manganese, and lastly iron, by means of sulphuretted hydrogen, modifying the condition of the liquids for the successive precipitations.

Zinc may be precipitated alone in the state of a very white sulphide by neutralising the solution entirely with ammonia, acidifying slightly with oxalic acid and passing in a rapid current of hydrogen sulphide. The liquid should be dilute and cold to prevent the formation of a deposit of zinc oxalate or of other metallic oxalates. The precipitate formed comprises the total zinc which may be determined as zinc sulphide after ignition in dry hydrogen sulphide.

If the solution from which the zinc has been eliminated contains merely nickel or cobalt, a little ammonia is added and some ammonia hydrosulphate. After digestion for a few minutes it is acidified with acetic acid, raised to a boil, and the nickel or cobalt sulphide is then collected on a filter. But it is necessary to ascertain if the precipitation is complete, by trying if the filtrate is not coloured brown or black when treated with ammonia and ammonium hydrosulphate. If there is a colouration it is necessary to decompose the hydrosulphate again with acetic acid at a boil. The precipitate is brought to the composition NiS or CoS by ignition in a Rosé crucible, traversed first by a current of hydrogen sulphide, and then by one of pure hydrogen.

If the solution contains only iron it is simply precipitated with ammonia and hydrosulphate.

If nickel and iron are simultaneously present the two metals may be precipitated and weighed together as monosulphides, by operating in the same manner as for nickel alone, or as it is indicated below.

Lastly, if after the elimination of the zinc the liquid still contains nickel, iron, and manganese, these three metals are separated by neutralising the feebly oxalic liquid with ammonia, adding an excess of neutral ammonium or sodium acetate, acidifying again slightly with acetic acid and passing in a solution of hydrogen sulphide for a very long time, then stoppering the bottle and letting the black precipitate of nickel and iron sulphides deposit. The filtrate, mixed with ammonia and hydrosulphate, gives a rose-coloured precipitate of manganese sulphide, perfectly free from other metals. On ignition in hydrogen sulphide it yields the green sulphide, MnS, of a perfectly definite composition.

The same process, consisting in the employment of

hydrogen sulphide in large excess in a slightly acetic solution, effects a very distinct separation of iron and manganese. It may be applied under various circumstances, and is sometimes preferable to the method with acetates at a boil, for this method is not perfect if the quantity of iron is considerable.

In the same case the separation of iron and zinc is effected incompletely by ammonia alone and even by the acetates. It succeeds better by the method with sulphides on condition of observing the following precautions:—Almost exact neutralisation with ammonia; dilution with much water; addition of ammonium chloride and only a small quantity of ammonium oxalate, so as not to have a deposit of iron oxalate, which would mix with the zinc sulphides and give it a black colour after ignition in hydrogen sulphide. If this accident occurs it must be calcined in pure hydrogen before weighing; then account must be taken of the sulphide FeS on re-dissolving in *aqua regia* and precipitating the small quantity of iron which has been entangled in the zinc with ammonia.

Thanks to the methods thus explained the analysis of the manifold alloys containing copper, zinc, nickel, and sometimes cobalt, manganese, and iron, the analysis of the cadmiferous, cupriferous, and ferruginous zinc ores, and that of the products of their metallurgical treatment, will become much easier and more simple than heretofore. —*Comptes Rendus*, cii., p. 678.

MANUFACTURE OF MINERAL COLOURS IN THE UNITED STATES.

THE following particulars, taken from the "Report of the United States' Geological Survey on the Mineral Resources of the States," have been forwarded to us by the author, Dr. Marcus Benjamin, F.C.S.

There are in the States 31 white-lead works, in all of which the so-called Dutch method is followed, the material used being pig-lead. The total produce during the year 1884 was about 65,000 tons.

A "sublimed lead" is made in Missouri by the direct oxidation of galena in a reverberatory furnace.

Zinc-white was manufactured in the same year to the extent of 12,000 to 15,000 tons. It is used not only as a colour but in the manufacture of india-rubber, in pottery, and in the paper trade.

Barium sulphate (heavy spar) was raised to between 25,000 and 30,000 tons. Barium compounds are used as paints under the names of blanc fixe, satin-white, &c., and in the form of peroxide for bleaching purposes. Barium sulphate, both the natural and the precipitated, is largely used as an adulterant.

Terra alba (ground gypsum) is imported from Nova Scotia, whilst a superior quality is brought from France. In addition to its legitimate use in making white pigments of a low grade it serves for adulterating a variety of commercial articles.

The quantity of red-lead produced in the United States could not be ascertained, but the imports at New York amounted to 198,588 lbs.

The American production of litharge is also an unknown quantity. The imports were only 54,183 lbs.

Concerning ochres it is said that with the possible exception of the deposits recently opened up near St. Louis, the American production is inferior to the imported qualities. "American ochres for the most part lack strength or tinting properties and require too much oil for grinding." The annual consumption in the United States is estimated at 10,000 tons, of which about 3000 tons are imported.

American umbers are inferior to those imported from Italy and Turkey. Siennas are found to a small extent in Virginia and Pennsylvania, but most of that used is imported from Italy.

There is no mention of lapis lazuli having been found in the United States, but there are two American manufactories of artificial ultramarine with a yearly output of 1400 tons.

Ground slate is used as a pigment to the extent of 2000 tons yearly, and occurs in four colours—green, red, slate, and drab.

SUGGESTIONS AS TO THE CAUSE OF THE PERIODIC LAW, AND THE NATURE OF THE CHEMICAL ELEMENTS.*

By THOS. CARNELLEY, D.Sc.,
Professor of Chemistry in University College, Dundee.

(Concluded from p. 186.)

General Conclusions.

A CAREFUL consideration of the points submitted above leads almost irresistibly to the conclusion *that the elements as a whole are analogous to the hydrocarbon radicles.* This is a conclusion which, if true, would further lead us to infer *that the elements are not elements in the strict sense of the term, but are in fact compound radicles, made up of* AT LEAST *two simple elements*, A *and* B.†

Generally speaking the elements, as I have endeavoured to show above, are analogous to hydrocarbon radicles, but differing from them in certain points, these differences depending most probably on the difference in the nature of one or more of the primary elements in the two cases. In making this analogy carbon and hydrogen are supposed to be primary elements.

Supposed Genesis of the Elements.

From the above point of view it should be possible to build up a series of compounds of two primary elements, A and B, corresponding to the—at present—so called elements. Such a system should fulfil the following conditions:—

(1.) The secondary elements generated from the two primary elements, A and B, must be capable of division into series and groups,—that is to say, they must exhibit the phenomenon of periodicity.

(2.) The several series must run in octaves.

(3.) The system must exhibit some feature corresponding to "odd and even series."

(4.) The atomic weights must increase across the system from the first to the seventh group,—*i.e.*, from the positive to the negative end of each series.

(5.) The atomicity (*i.e.*, valency) must increase from the first to the fourth or middle group, and then either increase or diminish to the seventh group.

6. It should exhibit some feature corresponding to the eighth group in Mendeljeff's classification of the elements.

(7.) The atomic weights in such a system should coincide with, or approximate to, the commonly received atomic weights of the elements.

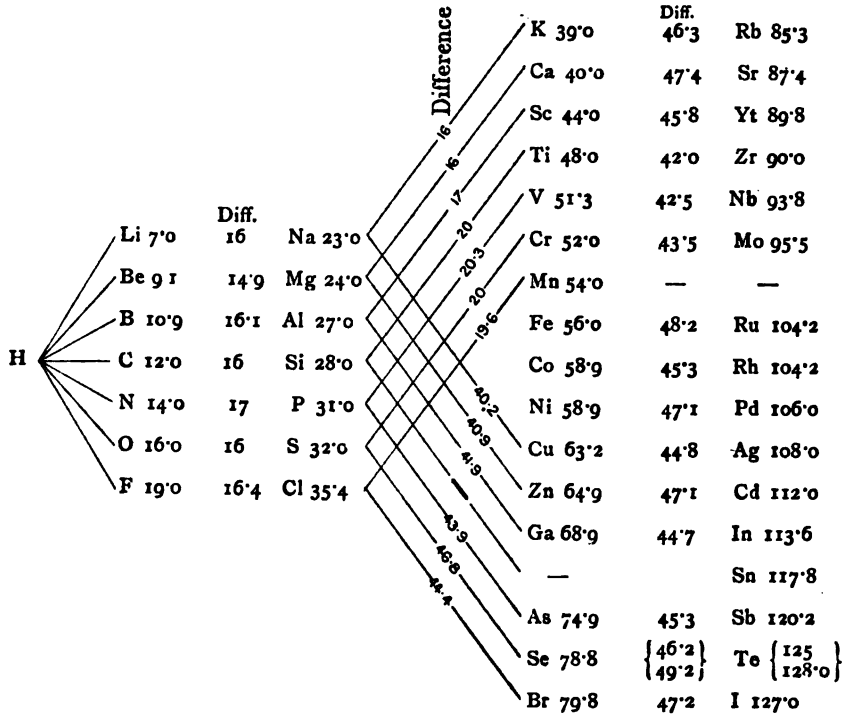
Though up to the present I have not been able to draw out a system which will rigorously accord with all the above conditions, still the one given in the lower half of Diagram VI.‡ fulfils all except the last. This condition is indeed the most important and crucial, but nevertheless the system proposed gives atomic weights which, with but few exceptions, approximate closely to those usually taken as the true atomic weights.

* A Paper read before the British Association, Aberdeen Meeting.

† If composed of more than two simple elements, it is probable that such primary elements will be but few in number.

‡ The *upper* part of this diagram is, with one or two slight modifications, identical with that proposed by Bayley (*Phil. Mag.* (5), 13, 26

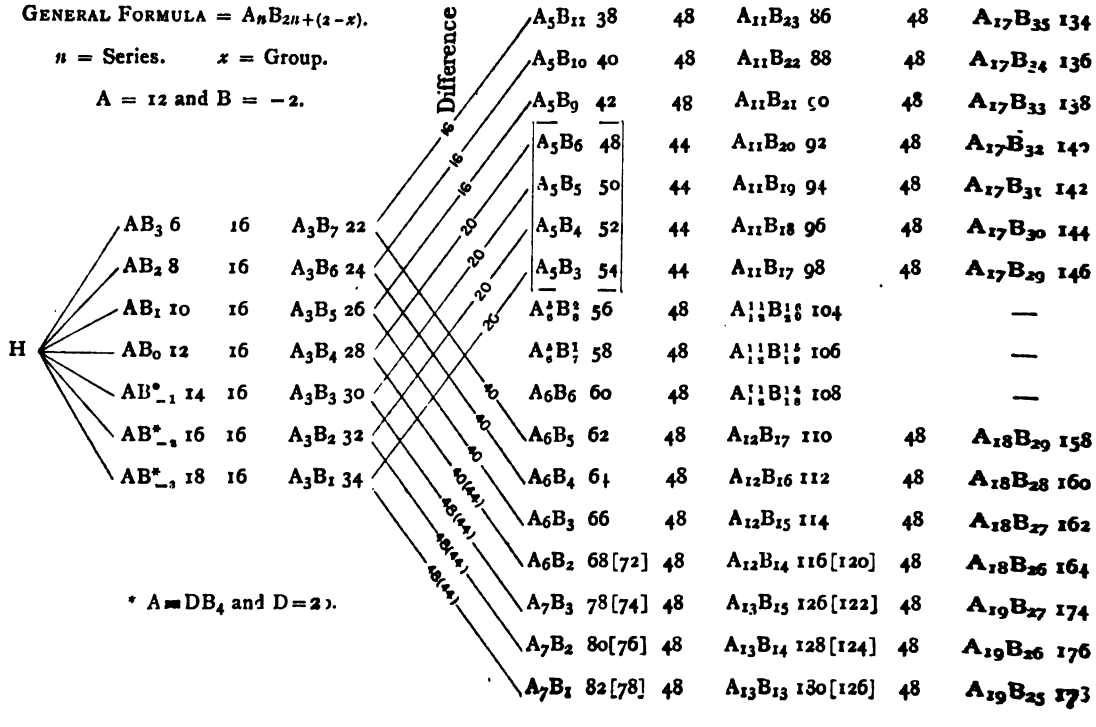
DIAGRAM SHOWING THE



GENERAL FORMULA = $A_nB_{2n+(2-x)}$.

n = Series. x = Group.

A = 12 and B = −2.



* A = DB_4 and D = 2).

SUPPOSED GENESIS OF THE ELEMENTS.

Diff.		Diff.				
	—		—	Monads.	Group I.	
	—		—	Dyads.	Group II.	
	—		—	Triads.	Group III.	
	—		Th 234	Tetrads.	Group IV.	*a.*
40·1	Ta 182·1		—	Triads or Pentads.	Group V.	
	W 184·0	56	U 240	Dyads or Hexads.	Group VI.	
	—		—	Monads or Heptads.	Group VII.	
	Os 198·5 (?)		—		Group VIII.	
	Ir 192·7		—			
	Pt 194·4		—			
	Au 196·2		—	Monads.	Group I. or IX.	
	Hg 200.		—	Dyads.	Group II. or X.	
	Tl 203·7		—	Triads.	Group III. or XI.	
	Pb 206·5		—	Tetrads.	Group IV. or XII.	*b.*
	Bi 207·5		—	Triads or Pentads	Group V. or XIII.	
	—		—	Dyads or Hexads.	Group VI. or XIV.	
	—		—	Monads and Heptads.	Group VII. or XV.	

GENERAL FORMULÆ.

40	$A_{22}B_{45}$ 174	56	$A_{29}B_{59}$ 230	$(A_nB_{2n+1})^{i}$		Group I.	*a.*
40	$A_{22}B_{44}$ 176	56	$A_{29}B_{58}$ 232	$(A_nB_{2n})^{ii}$		Group II.	
40	$A_{22}B_{43}$ 178	56	$A_{29}B_{57}$ 234	$(A_nB_{2n-1})^{iii}$		Group III.	
40	$A_{22}B_{42}$ 180	56	$A_{29}B_{56}$ 236	$(A_nB_{2n-2})^{iv}$	$(A_nB_{2n-4})^{iv}$	Group IV.	
40	$A_{22}B_{41}$ 182	56	$A_{29}B_{55}$ 238	$(A_nB_{2n-3})^{iii, v}$	$(A_nB_{2n-5})^{v}$	Group V.	
40	$A_{22}B_{40}$ 184	56	$A_{29}B_{54}$ 240	$(A_nB_{2n-4})^{ii, vi}$	$(A_nB_{2n-6})^{vi}$	Group VI.	
40	$A_{22}B_{39}$ 186	56	$A_{29}B_{53}$ 242	$(A_nB_{2n-5})^{i, vii}$	$(A_nB_{2n-7})^{vii}$	Group VII.	
	$A^{11}_{22}B^{21}_{42}$ 192		—			Group VIII.	
	$A^{11}_{22}B^{21}_{41}$ 194		—				
	$A^{11}_{22}B^{21}_{40}$ 196		—				
40	$A_{23}B_{39}$ 198		—	$(A_nB_{2n-7})^{i}$		Group IX.	*b.*
40	$A_{23}B_{38}$ 200		—	$(A_nA_{2n-8})^{ii}$		Group X.	
40	$A_{23}B_{37}$ 202		—	$(A_nB_{2n-9})^{iii}$		Group XI.	
40	$A_{23}B_{36}$ 204[208]		—	$(A_nB_{2n-10})^{iv}$	Possibly $(A_nB_{2n-4})^{iv}$	Group XII.	
32	$A_{23}B_{35}$ 206[210]		—	$(A_nB_{2n-11})^{iii, v}$	$(A_nB_{2n-5})^{iii, v}$	Group XIII.	
32	$A_{23}B_{34}$ 208		—	$(A_nB_{2n-12})^{ii, vi}$	$(A_nB_{2n-6})^{ii, vi}$	Group XIV.	
32	$A_{23}B_{32}$ 210		—	$(A_nB_{2n-13})^{i, vii}$	$(A_nB_{2n-7})^{i, vii}$	Group XV.	

Of the atomic weights represented by this system—

27 agree almost exactly with the actual numbers.
19 are not more than 1 unit out.
5 ,, ,, 1·5 units out.
6 ,, ,, 2 ,,
3 ,, ,, 3 ,,
1 (viz., Sb) is 5·8 units out.

61 = Total.

Ag, Au, and Te are not included in the above, because the positions of Ag and Au are not known with certainty, for they may belong either to Group VIII., in which case the calculated numbers would be correct, or to Group I. (IX.), for which positions the calculated numbers are about 2 units too high. As regards Te, there are two numbers which claim to represent its atomic weight, viz., 125 (Brauner) and 128 (Wills, Berzelius, &c.), of which the former is most probably the true one.

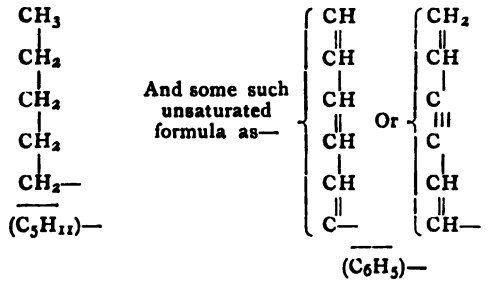
The similarity between the upper and lower parts of the Diagram VI. is strikingly illustrated by the *differences* between the atomic weights of successive periods.

With regard to the *structure* of the system represented in the lower half of the diagram the following remarks are necessary :—

First. The binary elements of this system (except Ti, V, Cr, and Mn, the general formula for which would be $A_nB_{2n+(4-x)}$) may all be represented by the general formula $A_nB_{2n+(2-x)}$, in which A = 12 and B = −2, whilst x = the group and n the homologous series to which any element belongs. A is supposed to be a tetrad element identical with carbon, and B a monad element.

Second. As represented in the diagram the atomic weights are all *even integers*. This is due to the value for B, which, for the sake of simplicity, has been taken as = −2; whereas, if the theory be correct, if should have a value somewhere between −1·99 and −2·00. Such a value would, on the whole, bring the calculated atomic weights more into accord with the actual numbers.

Third. The difference between what are commonly called odd and even series is indicated by the diagram to be due to the several series beginning with K, Rb, Cs, &c., consisting of *saturated* binary elements, whereas the series beginning with Cu, Ag, Au,* &c., consist of *unsaturated* binary elements. Thus the difference between K, on the one hand, and Cu on the other, is analogous to the difference between some such saturated formula as—



Fourth. If A = 12, then Nitrogen = AB_{-1} = 14
Oxygen = AB_{-2} = 16
and Fluorine = AB_{-3} = 18.

Now if A be really a primary element, and therefore indivisible, it would be impossible to take B from it, as indicated by the formula AB_{-1} for N, and the two following formulæ for O and F. This difficulty would, however, be removed by substituting DB_4 for A throughout the whole scheme, D being a heptavalent element of atomic weight = 20. By this substitution neither the atomic weights nor the general structure of the diagram would be affected.

Fifth. If there be any truth in the above speculation as to the genesis of the chemical elements, then the existence of elements of *identical atomic weights*, and isomeric with one another, would be possible. May not Ni and Co, Ru and Rh, Os and Ir, and some of the rare earth metals, be isomers in this sense? If this be so, it would remove one of the principal objections which have been raised against the truth of the Periodic Law.*

Sixth. In the scheme represented in Diagram VI. the chemical elements are all (except hydrogen) supposed to be composed of two simpler elements, viz., A = 20, and B = −2. Of these A is identical with the element carbon, whilst B is a substance of negative weight, possibly the ethereal fluid of space?

Supposing the theory advanced above to be true, then it is interesting to observe—

That whereas the hydrocarbons are compounds of carbon and hydrogen, the chemical elements would be compounds of carbon with ether (atomic weight = −2), the two sets of bodies being generated in an exactly analogous manner from their respective elements. There would hence be three primitive elements, viz., carbon, hydrogen, and ether.

Truly this is a bold, though most interesting, speculation,† and one which would need very ample confirmation—and no doubt some considerable modification—before it could be generally accepted by chemists. It is offered simply as a speculation, with the object of indicating new lines in which research is required, and as possibly throwing some light, however dim, on the cause of the Periodic Law and the nature of the chemical elements.

* Assuming that these metals belong to Group I. (IX.).

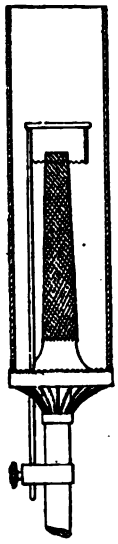
DR. AUER'S INCANDESCENT GAS-BURNER.

In the *Journal of Gas Lighting* for February 16 last (p. 302), a few particulars, extracted from the *Journal für Gasbeleuchtung*, were given of the new incandescent gas-burner invented by Dr. Auer, of Vienna; and it may be remembered that our contemporary awaited further information respecting the burner before pronouncing definitely as to its value. As the publication in question has not since referred to the subject, it is to be presumed that the desired information has not been obtained. We are enabled, however, to supplement the account of the new light which has already appeared in our columns by the following additional particulars, for which we are indebted to the last number of the *Journal des Usines à Gaz*, whence the annexed diagram has been copied. The apparatus consists simply of an ordinary Bunsen burner, above which is suspended a conical cylinder, formed of specially prepared cotton or woollen fabric, about 2½ inches high. This cylinder, as will be seen, is supported by a thread of platinum, which runs through its upper part, and is attached to two iron rods connected at the top to a ring. The longer of these rods is mounted upon a metal ring or collar encircling the stem of the burner, and adjustable by means of a screw. When the burner is lighted, there is considerable development of heat within the cylinder, which in a few seconds is raised to incandescence, producing a remarkably steady and brilliant white light. Nothing is said, however, as to the actual illuminating power (as tested by the photometer) obtained from this glowing cone; and this is a matter on which some figures will be awaited with interest. As to the material of which the cylinder is composed, it appears, according to the specification of Dr. Auer's French patent,

* In this connection compare the article on the Decomposition of Didymium, by Welsbach, in *Nature*, xxxii., 435; also Chemical News, 1885

† I have dealt with the question entirely from my own point of view, but there are many other circumstances which might be adduced in favour of the compound nature of the elements, including the results obtained by Abney (*Proc. Roy. Soc*, xxxi., 416; *Journ. Chem. Soc.*, xlii., 131) in regard to the infra-red absorption-spectra of certain carbon compounds, and the arguments advanced some time ago by Lockyer and others.

to be either oxide of lanthanium and zirconium, or oxide of yttrium and zirconium. The latter may be replaced by a quantity of erbium free from other elements belonging to this group of rare oxides; and the former, by oxides whereof the elements belong to the group of rare earths which are found in cerite. Further, the zirconium may be entirely or partially replaced by magnesia. In the formation of the cylinder, the cotton or woollen material is plaited into the required cone shape, and impregnated with a solution of nitrate or acetate of one of the before-mentioned substances; and the tissue having been carbonised, there is left behind, as residue, the earthy matter



in the form originally given to the tissue. Consequently, without any special manipulation being required, the burner may be supplied with its incandescent material. Dr. Auer does not confine himself to the cone-shaped cylinder: but in the event of other forms being adopted, he advises that the more exposed parts of the material should be strengthened by a solution of nitrate of magnesia and alumina. Such is briefly the new incandescent gas-light which it has been stated is to effect a complete revolution in the gas industry.—*Journal of Gas Lighting.*

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 188.)

PROF. H. W. WILEY said, on behalf of the committee, in presenting this report:—

Mr. President, your committee, after having carefully considered the results of the analytical work done on the samples of fertilisers furnished by it to the members of this Association, have concluded that the plan recommended by the committee at Philadelphia, with a few modifications, should be continued during the coming year. The chief alterations which we propose, you will already have noticed, are the following:—

(1) We recommend the abandonment of the use of hydrochloric acid in the preliminary digestion of the sample. All the potash salts in fertilisers which are likely to be of any use whatever to the growing plant are soluble in water, unless it be in the few cases, such as ground tobacco stems, cotton-seed hulls, &c., where we recommend a preliminary incineration with sulphuric acid. This will leave the potash in the form of sulphates readily soluble in water. We consider the preliminary use of hydrochloric acid as prejudicial. In the subsequent addition of barium hydrate the first portions of it are consumed in neutralising the free hydrochloric acid present, and thus an amount of barium chloride is found in solution which will require a corresponding amount of ammonium carbonate afterwards to precipitate. As is well known, the precipitates of barium salts carried down with them traces of the potassium. It is true that the amount of potassium thus lost is not great, yet every method should be used which is possible to make it a minimum. It is for this reason, also, that the addition of barium chloride and of barium hydrate and of ammonium carbonate should be made, as indicated in the report of the committee, drop by drop, and in as slight excess as possible.

(2) The object of the recommendation to add a little oxalic acid or oxalate of ammonium is to facilitate the conversion of any nitrates of potash which may be present into carbonates on subsequent evaporation and ignition. By this means it appears to the committee that a single evaporation and ignition of the sample will be sufficient, and hence they have recommended that the second one, as proposed in the Philadelphia method, be abandoned. Subsequently, before the addition of the platinic chloride, we add two drops of hydrochloric acid, in order to convert any carbonates which may have been formed by the above process into chlorides.

(3) As will be seen in the report of the committee, numerous experiments show that the weight of K_2PtCl_6 obtained, in the first instance, when the processes have been properly performed, is an entirely sufficient basis for the calculation of the percentage of potash present. Hence there seems to be no necessity for washing out the double chloride with hot water and re-weighing, or for the reduction of the platinum in a current of hydrogen, washing out the potassium chloride, and re-weighing the metallic platinum.

In respect of the factor to be emp'oyed, the committee do not feel warranted in recommending a change; they recommend, however, that the factor based on the new atomic weight of platinum, as determined by Seubert, be given a thorough trial during the coming year, and the results be reported to the Association at its next annual meeting.

Dr. JENKINS said, referring to the Potash Committee's report:—

The recommendation of the committee to dissolve potash in fertilisers without the use of acid is, I believe, very wise.

If acid is used in the extractive, there is a temptation, which some manufacturers have been unable to resist, to put in greensand marl, which may contain as much as 8 per cent of potash quite insoluble in water, and probably not readily available by plants. I believe no special precaution is necessary to separate N_2O_5 before making a potash determination, because most, if not all, is expelled in the usual method of procedure, as the following trials show: Two fertilisers having 2·96 and 1·38 per cent of nitrogen in the form of N_2O_5 were treated as for the determination of K_2O, but instead of adding platinum chloride the concentrated solution was tested for N_2O_5 with negative results. 0·05 grm. of KNO_3 was dissolved in water, NH_4Cl and $(NH_4)_2Cl_3$ were added, evaporated, and ignited.

The residue contained no N_2O_5.

25 grms. of $NaNO_3$ with 1¼ equivalents of NH_4Cl (0·888 grms.) in solution was evaporated and ignited. In the residue was found chlorine equivalent to 96 per cent of the nitrogen originally present which had been displaced by it.

A sample of acid rock had sufficient KNO_3 added to it to give 6·45 per cent of N_2O_5 and 12·64 per cent of K_2O. Taking no special precautions, on account of the nitric acid present, a determination showed 12·72 of K_2O.

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D. North Carolina Agricultural Experiment Station, Secretary.

Mr. GLADDING then read the following paper, which was ordered to be spread on the minutes :—

On the Estimation of Potash.

The standard method of estimating potash consists in evaporating the solution, which must contain the potash in the form of chloride, with excess of $PtCl_4$ solution, nearly to dryness, washing the residue with strong alcohol, and weighing as K_2PtCl_6.

A strongly advocated modification of the above is the method of Tatlock, the main feature of which is a preliminary washing with 2 or 3 c.c. of a strong platinum solution and final washing with alcohol. This method has the great advantage of estimating potash directly, whether in the form of chloride, sulphate, or nitrate.

In all the published experiments on the standard method we find a tendency to high results. Even when chemically pure KCl and NaCl are used without a mixture of other salts, and when the platinum solution has been refined to the utmost purity, this tendency to excess is recognised.

Thus Fresenius, in order to insure removal of all NaCl after washing with alcohol, recommends washing a few c.c. of water and recovery of any dissolved potash salt from the washings.

The committee of the British Association finds that in case the platinum solution is in large excess the results are 5 to 6 per cent too high, and this even when chemically pure KCl alone is employed.

It is manifest that in many cases of commercial analyses where the contents of potash are unknown this large excess and consequent error cannot be avoided.

Again, it has been found that even when the platinum solution gives a blank experiment, a residue perfectly soluble in alcohol, it may, from presence of certain impurities, give results far too high when working with chemically pure KCl.

When, then, to the above considerations we add the conditions under which the process is used in commercial analysis, especially in fertiliser work, and the difficulty of removing all sulphuric acid, nitric acid, organic matter, lime, salts, &c., and obtaining a solution containing nothing but pure KCl and NaCl, the greater tendency to error is at once evident.

On the other hand, the fact that in Tatlock's method the potash can be estimated directly without removal of sulphuric or nitric acids is a strong argument in favour of its use, and were it not for the one objection—that there is a loss varying from 0 to 0·5 per cent—we should certainly prefer it to the standard method.

The labour and great care required to make an accurate potash estimation by the standard method in fertiliser analysis has led to an examination of a method proposed by Lindo,* which seems to possess all the advantages of Tatlock's method, and at the same time to be free from a tendency to low results.

Lindo made 10 analyses of a mixture of KCl with 25 per cent $MgSO_4$ and 10 per cent NaCl.

This mixture was evaporated as usual with excess of platinum solution and the precipitate washed thoroughly with alcohol as usual, until all platinum salts except the potash salt has been removed.

A half saturated water solution of NH_4Cl was shaken in a bottle with K_2PtCl_6 till saturated with the latter.

This salt is very slightly soluble in the NH_4Cl solution and only a trifling amount is taken up.

This solution was used to dissolve out any Na_2SO_4 or chloride of the same bases from the precipitate.

A final washing with alcohol removed all NH_4Cl, and the Gooch crucible contained only pure K_2PtCl_6. His results were as follows :—(See next column).

KCl taken.	Weight of precipitate.	KCl obtained.
0·46239	1·5148	100·11
0·40955	1·3404	100·02
0·42510	1·3920	100·07
0·41477	1·3597	100·18
0·45149	1·4797	100·16
0·48252	1·5805	100·10
0·44488	1·4552	99·96
0·48679	1·4244	99·66
0·48062	1·4050	99·71
0·41726	1·3649	99·96
		99·99

This proposed method was submitted to the following investigation :—

Chemically pure KCl was obtained by re-crystallising chemically pure $KClO_3$, and fusing to convert it to KCl.

0·25835 grm., if this KCl gave 0·4967 grm. AgCl, equal to 0·25836 grm. KCl.

5 c.c. of the platinum solution employed evaporated to dryness dissolved perfectly in 90 per cent alcohol.

A solution of KCl in water was now made. By weighing this solution the KCl employed in all subsequent experiments was very accurately determined. Using KCl alone, Lindo's method gave the following results :—

	KCl taken.	Weight of precipitate.	KCl obtained.
(1)	0·24618	0·80650	100·11
(2)	0·12752	0·41770	100·06
(3)	0·12395	0·40550	99·98

These analyses show that there is no tendency to loss by this method.

To test the method applied to the estimation of potash in the form of sulphate, chemically pure K_2SO_4 was employed, using an excess of platinum solution and several c.c. of HCl. The results were as follows :—

	K_2SO_4 taken.	Weight of precipitate.	K_2SO_4 obtained.
(1)	0·12539	0·8580	100·95
(2)	0·13228	0·3790	102·81
(3)	0·49780	1·4148	101·45

These results show that with HCl alone added the precipitate is not pure K_2PtCl_6. It may be that the presence of free H_2SO_4 causes the error.

To test this an amount of NaCl about equal to the K_2SO_4 was added in the following experiments, thus avoiding presence of free H_2SO_4 :—

	K_2SO_4 taken.	Weight of precipitate.	K_2SO_4 obtained.
(1)	0·134977	0·3782	100·01
(2)	0·121427	0·3415	100·16
(3)	0·122500	0·3429	99·95

The method was now applied to the estimation of potash in superphosphate, using the following mixture :—To 60 parts of an acid phosphate were added 10 parts each of the following salts : $NaNO_3$, NaCl, $MgSO_4$, and $(NH_4)_2SO_4$.

A blank experiment, using 1 grm. of this mixture, gave 0·08 per cent potash.

This amount was deducted in subsequent experiments.

Experiment 1.—One grm. + 0·07484 grm. KCl, containing 0·0478 grm. K_2O, gave 0·2464 grm. K_2PtCl_6. Taken, 4·78 per cent ; obtained, 4·75 per cent.

Experiment 2.—One grm. + 0·02748 grm. K_2SO_4, containing 0·01485 grm. K_2O, gave 0·01486 grm. K_2O. Taken, 1·485 per cent ; obtained, 1·486 per cent.

A second mixture, which was received from Dr. E. H. Jenkins, and which contained 12·62 per cent K_2O by composition, gave by this method 12·61 per cent, 12·56 per cent, 12·63 per cent.

These very satisfactory results as regards accuracy taken in connection with the far easier manipulation, have led to the adoption by our firm of the following scheme for the estimation of potash in fertilisers :—

* CHEMICAL NEWS, xliv., p. 130, note.

(1.) *Superphosphates.*—Boil 10 grms. of the fertiliser with 300 c.c. of water for ten minutes. Cool the solution, add ammonia in slight excess, thus precipitating all phosphate of lime, oxide of iron and alumina, &c., make up to 500 c.c., mix thoroughly, and filter through a dry filter; take 50 c.c., corresponding to 1 grm., evaporate nearly to dryness, add 1 c.c. of dilute H_2SO_4 (1 to 1), and evaporate to dryness and ignite to whiteness. As all the potash is in form of sulphate, no loss need be apprehended by volatilisation of potash, and a full red-heat must be used until the residue is perfectly white. This residue is dissolved in hot water plus a few drops of HCl: 5 c.c. of a solution of pure NaCl (containing 20 grms. NaCl to the litre) and an excess of platinum solution (4 c.c.) are now added, and the whole evaporated as usual. The precipitate is washed thoroughly with alcohol by decantation and on filter, as usual. The washing should be continued even after the filtrate is colourless. Ten c.c. of the NH_4Cl solution, prepared as above, are now run through the filter. These 10 c.c. will contain the bulk of the impurities, and are thrown away. A fresh portion of 10 c.c. NH_4Cl is now run through the filter several times (five or six). The filter is then washed thoroughly with chemically pure alcohol, dried, and weighed as usual. The platinum solution used contains 1 grm. metallic platinum in every 10 c.c.

(2.) *Muriates of Potash.*—In the analysis of these salts an aliquot portion containing 0·500 grm. is evaporated with 10 c.c. platinum solution plus a few drops of HCl, and washed as before.

(3.) *Sulphate of Potash, Kainite, &c.*—In the analysis of these salts an aliquot portion containing 0·500 grm. is taken, 0·250 grm. of NaCl added, plus a few drops of HCl, and the whole evaporated with 15 c.c. platinum solution. In this case special care must be taken, in the washing with alcohol, to remove all the double chloride of platinum and sodium. The washing should be continued for some time after the filtrate is colourless. 25 c.c. of the NH_4Cl solution are employed instead of 10 c.c., and the second 25 c.c. poured through at least six times to remove all sulphates and chlorides. Wash finally with alcohol, dry, and weigh as usual.

A single experiment attempting to estimate potash directly in nitrate of potash did not yield satisfactory results. In such cases it may be necessary to first evaporate to dryness with HCl, and then proceed as in analysis of muriates.

To test the solubility of K_2PtCl_6 in the NH_4Cl solution prepared as above, 3·13 grms. of finely pulverised K_2PtCl_6 were digested with 200 c.c. of the NH_4Cl solution, and filtered through a Gooch crucible. The loss was found to be 0·0002 grm.

Wherever the standard method of estimating potash is employed, the washing of the precipitate of K_2PtCl_6 with the NH_4Cl solution would undoubtedly be a valuable addition to the present process.

To prepare the washing solution of NH_4Cl, place in a bottle 500 c.c. H_2O, 100 grms. NH_4Cl; shake till dissolved. Now pulverise 5 or 10 grms. of K_2PtCl_4, put in the bottle, and shake at intervals for six or eight hours; let settle over night; then filter off liquid into a second bottle. The first bottle is then ready for a preparation of a fresh supply when needed.

Laboratory of Stillwell and Gladding.

(To be continued).

On a New System of Lighting known as Pneumatic Lighting. — M. Bender. — The fuel is not the volatile petroleum products, but the fatty residues from the rectification of crude mineral oils. There is produced an open flame like that of a gas-burner, which gives off no smoke. A current of air, laid on in pipes like gas, is passed through the oil. The advantages alleged are cheapness and immunity from explosions, but portability is sacrificed.—*Moniteur Scientifique.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Part 5.

Action of Paratoluidine on Resorcine and Hydroquinone.—A. Hatschek and A. Zega.—Resorcine and hydroquinone react with paratoluidine in a manner quite analogous to that of aniline under similar circumstances. If these dioxybenzols are heated with paratoluidine and calcium chloride to 260° to 270° there is formed much meta- or para-oxyphenyl-paratolylamine, and little ditolylised meta- or para-phenylendiamine.

Calorimetric Investigations.—F. Stohmann (Sixth Memoir: On the Thermic Value of Benzol).—The combustion-heat of liquid benzol is, according to Berthelot, 776,000 cal.; according to the author, 779,530 cal.; but according to Thomsen, 791,870 cal.

The Cerium Oxides in their Practical Application.—Dr. J. R. Strohecker.—The author considers the ceriferous clays as pigments and raises questions as to their possible agricultural and medicinal action.

Moniteur Scientifique, Quesneville.
3rd Series, Vol. xvi., April, 1886.

On Lakmoid, Litmus, Phenolphthaleine, and other Alkalimetric Indicators. — R. Thomson. — From the Chemical News.

On Different Bleaching Agents. — G. Lunge and L. Landolt.—An examination of certain novel bleaching agents. The authors have studied the so-called "chlorozone," which they conclude is a solution of free hypochlorous acid in a solution of sodium chloride. Dr. Lunge and M. Landolt have prepared the article themselves, following literally all the directions given in the specification. They have further examined the products of the action of chlorine upon magnesia, the behaviour of chlorine with zinc hydroxide, aluminium hypochlorite, the preservation of bleaching-solutions, the conversion of chloride of lime into calcium chloride, and they have, lastly, made comparative experiments with different bleaching-agents. They find that the magnesia-liquor acts almost as slowly as that of lime, whilst the aluminium, and especially the zinc, solutions are very active. The treatment of the bleaching-liquor with a current of carbonic acid heightens its decolourising power in all cases.

On Artificial Colouring-matters applied in the Arts.—A Course of Lectures delivered by Dr. E. Noelting at the Mulhouse School of Chemistry.—In this third lecture the author treats of the derivatives of triphenylmethane.

Chemistry of Colours.—J. M. Thomson.—A lecture delivered, apparently, before the Society of Arts.

The Pleasure Voyages of M. Grawitz in Company of his Ungreenable Aniline-Black.—A humorous account of the riots at Renaix, in Belgium, in connection with the proceedings taken by a M. Grawitz to enforce a patent for ungreenable aniline-blacks. [Street-fighting seems to us an undesirable novelty in patent-litigation.]

Properties and Proprietors of Aniline-Black.—Camille Kœchlin.—The author contends that blacks developed in heat, whether in printing or dyeing, are permanent, whilst those produced below 75° turn more or less green. An ungreenable steam aniline-black was obtained by Cordillat in the very year of Lightfoot's original discovery.

A New Elementary Body, Germanium.—Already noticed.

Determination of Potassium Tartrate in Crude Argols and Lyes of Wine.—Dr. Klein.—This paper, credited to the CHEMICAL NEWS, was originally taken from the *Zeitschrift für Analytische Chemie.*

The Influence of Climate on the Flavour of Beer.—M. Velten.—In this paper, taken from the *Wochenschrift für Brauerei*, the author argues that local differences of flavour, which he fully admits, are due to different ferments present in the air and the brewery-plant, and becoming more or less mixed with the normal alcoholferment.

French Patents connected with the Chemical Arts.—A list of titles for December last.

Industrial Review and Patents.—A selection of abstracts from *Chemische Industrie*, *Dingler's Journal*, the *Chemiker Zeitung*, &c., concerning cryolite glass; the spontaneous ignition of packing materials in which bottles of nitric acid are conveyed; the action of different elements, and their oxides and sulphides, on the fixation of the halogens in organic molecules; practical applications of synthesis by means of aluminium chloride; process for the oxidation of the petroleum hydrocarbons and their analogues for their conversion into acids; proportion of pseudocumene and mesitylene in different mineral oils; preparation and uses of algine; the analysis of the commercial aniline oils; and critical observations on the last-mentioned paper.

Patents taken out in Berlin.—Abstracts of the specifications of processes for the utilisation of the acid residues from refineries of coal-tar and mineral oils; preparation of aluminium from its fluoride; preparation of benzoic sulphinide by means of sulpho-conjugated benzoic acids; preparation of a substance analogous to wax, and known as "ceroid" from the grease of wool; preparation of ortho-nitro-amido-para-methoxyl benzine and ortho-nitro-amido-para-ethoxyl benzine by the action of ammonia upon mono-nitro-dimethyl hydroquinon and mono-nitro-diethyl-hydroquinon; process for preparing a thio-para-toluidine and derived azo colouring-matters; process for preparing dry alizarine which in contact with water resumes the consistence and properties of alizarine-paste.

Academy of Medicine: On the Ptomaines, the Leucomaines, and the Microbian Theory.—Armand Gautier.—A critique of a recent memoir by M. Peter.

Fibre of China Grass.—A. Sansome.—From the *Journal of the Society of Dyers and Colourists.*

The Present Depreciation of the By-Products of the Distillation of Coal.—In this report we find a summary of matter taken from the report recently presented at the Annual Meeting of the South Metropolitan Gas Company, from a report made by Dr. Bunter to the Society of German Gas-Engineers, and from a memoir read by Mr. G. E. Davis before the London Section of the Society of Chemical Industry. It appears that coal-tar is in danger of becoming absolutely unsaleable. The demand for ammonia may possibly improve. Its rival product, Chili saltpetre, seems to have reached its minimum point in price, and the manufacturers are combining to limit production. On the other hand, the demand for ammonia is likely to increase, owing to the Solvay alkali process and its use in refrigerating-machines.

The Great Lavoisier Medal.—M. Knieder having apparently withdrawn his claims, M. Michel Perret, inventor of the stage-furnace for burning pyritic smalls, seems to be the sole candidate.

The Industrial Society of Mulhouse. Chemical Committee (Session of February 10th, 1886).

M. Weber wished to define more clearly the meaning of a phrase used in his memoir on red stains in calicos printed with aniline-black. He did not intend to say that such spots were not often caused by traces of acids remaining in the tissue, but merely that such traces were not the sole cause.

M. Rosenstiehl, in a memoir published as early as 1871, had shown that such stains were due sometimes to traces of acids, but also sometimes to the nature of the cotton used.

M. Durand wrote that the first idea of applying, in printing and dyeing, the green lakes formed by certain nitroso-phenols with the salts of iron, was due to M. Philippe Greiff, in 1882. He experimented with two nitroso-phenols and with dinitro-resorcine.

G. Schoen mentioned that in 1875 he had successfully used, in place of gum, a product known as apparatine,—a fact which may be of practical interest on account of the present high prices of gums. Apparatine is made by adding to 76 litres of water 16 kilos. of starch, stirring constantly, and then 8 kilos. of caustic soda at 25° B., stirring constantly for an hour. The thickening is recommended for light catechus used for grounds.

German Review.—A series of abstracts from the *Berichte der Deutschen Chemischen Gesellschaft.*

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 6, March 15, 1886.

Results of the Application of the Method for the Prevention of Hydrophobia after a Bite.—M. Pasteur. The reproduction of a medical paper read before the Academy of Sciences and the Academy of Medicine.

The Preparation and the Physical Properties of Phosphorus Pentafluoride.—H. Moissan.—Already noticed.

On Certain Proximate Principles of the Rind of Bitter Oranges.—C. Tanret.—Already noticed.

On Red Stock-Fish.—P. Carles.—Under this name is described a peculiar decomposition recently occurring in salt cod, due, it is said, to the multiplication of a red micrococcus. The sanitary bearings of this novel kind of decomposition are undecided.

On an Irvingia from Cochin China, and the Fatty Matter which it Yields.—J. Léon Soubeiran.—The fat in question is soluble in hot alcohol, ether, chloroform and carbon disulphide. It melts at 38° and solidifies at 31°. It contains 30·2 per cent of oleic acid and 38·5 of other fatty acids; its odour is offensive.

Novel Synthesis of Hydrocyanic Acid.—Albert Figuier.—Already noticed.

On a Characteristic Reaction of the Sulpho-conjugated Derivative of Magenta.—Dr. Ch. Blarez.—Already noticed.

Hopeine and Morphine.—A. Petit.—Already noticed.

Disinfection of Cattle-Trucks.—P. Redard.—The author has found experimentally that treatment with superheated steam at 110° is the only trustworthy disinfectant.

The Use of Certain Antiseptics for the Hygeia of the Mouth and the Teeth.—Dr. Miller.—A medical paper.

Pyrogallic Acid as a Reagent for Nitric Acid.—M. Curtman.—From the *Analyst.*

On Colocynthine, Elaterine, and Bryonine.—Johannson.—From the *Zeitschrift für Anal. Chemie.*

The Assay of Honey.—Otto Hehner.—From the *Analyst.*

Determination of Glycerine.—W. Fox and J. Wanklyn.—From the CHEMICAL NEWS.

MEETINGS FOR THE WEEK.

MONDAY, 26th.—Philosophical Club, 6.30. (Anniversary).
TUESDAY, 27th.—Royal Medical and Chirurgical, 8.30.
SATURDAY, May 1st.—Royal Institution, 1·30. (Annual Meeting).

THE CHEMICAL NEWS.

Vol. LIII. No. 1379.

DR. KOCH'S GELATIN-PEPTONE WATER-TEST.*

By Prof. G. BISCHOF.

We have repeatedly been painfully reminded of the fact that chemical analysis may fail to indicate danger in samples of water, when it exists in its gravest form. The occasional discharge by a single man into millions of gallons is beyond the reach of chemistry, whilst the experience at Caterham and Redhill a few years ago proved that any specific virus in the discharge may be the cause of an epidemic. The search for such virus amongst the organised living matter is therefore of supreme importance, and the biological water-test proposed by Dr. Koch, opening a prospect of success in that direction, was received by many who had been engaged in the examination of water, as a delivery from the uncertainty surrounding this important branch of laboratory operations. How far has it realised our expectations?

The test gives two indications,—the number of colonies, total and liquefying, formed by the centres or microphytes contained in a sample of water, and a microscopic examination. No reference is generally made in reports to the latter. I have examined many hundred different samples, subjecting the test also to numerous experiments, and now beg leave to submit the following conclusions:—

(1.) The number of colonies agrees in most cases very closely in parallel tests of the same sample. Dr. P. Frankland and I made independent tests for three months of the total colonies in the supply of the several Metropolitan Water Companies. This embraced nearly fifty samples, with the result that we both assigned to each Company almost precisely the same place, showing the close agreement even in the hands of different operators.

(2.) In comparing different samples, those which have a like history—which therefore are in fact alike—are almost always readily recognised as such by the number of colonies; but any difference in the treatment to which samples may previously have been subjected may entirely upset all attempts to draw correct conclusions from that number. To make this clear we will suppose that water is passed from one and the same source, in an otherwise precisely like manner, through two pipes. The question arises whether an infiltration of sewage takes place into one of them, and we test samples of the water, which has passed through each pipe. If we find a like number of colonies in both, there is in all probability no such pollution. But should the pipes be subjected to different temperatures, and the water in one of them become cooler than in the other, or should there be any material difference in the time of transit in them, the conclusions drawn from the number of colonies may be misleading. We have therefore, in the first instance, to consider the conditions upon which the development of microphytes, and thereafter the number of colonies, depend.

Temperature is perhaps of the greatest influence, because development is entirely suspended near the freezing-point, and accelerated to a most extraordinary degree as gradually 30° to 40° C. are approached. From this it appears clear that, as far as the number of centres is concerned, a deep-well water with 12° C. cannot be strictly compared to a river water with, say, 2° C.

The food required by microphytes for their development is derived from all and every kind of matter of organic origin, as also from a variety of compounds of inorganic nature. The leaves which fall into a river, the natural hay-infusion carried into it in the autumn, the manure washed into it, various mineral salts derived from rocks or otherwise,—everything is their prey, and may greatly influence development. A few drops of a sterilised solution of sodic phosphate added to a sample of water will make a striking difference in the number of colonies obtained by culture; in fact we must recollect that the multiplication of microphytes is not as much limited by their power of propagation as by the conditions surrounding them. One single bacterium termo, Prof. Cohn has told us, might, under sufficiently favourable conditions, fill up the entire ocean in less than three days with its progeny.

The following experiments were made with a view of ascertaining the influence of time or storage upon the number of colonies, it being self-evident that all samples which we may test have undergone some kind of storage:—

(*a*.) New River water, which would have been styled "very good" by Dr. Koch had it even contained twice the number of colonies found, was kept for six days in my laboratory in a sterilised flask, protected against aërial contamination. The result was a gradual increase of microphytes from day to day by self-multiplication from 1 liquefying or a total of 53 colonies, to 640 liquefying or a total of 770,000 colonies per cubic centimetre. The latter figure is seventeen times in excess of the total colonies found in a sample of Thames water, which I took a few months ago at London Bridge, the liquefying colonies also comparing unfavourably. This proves the predominating influence of storage when compared even with such a relatively polluted water as that of the Thames at London Bridge.

(*b*.) After adding to the above sample of New River water 1 per cent of sewage, which had been filtered through paper, the total colonies increased almost 600 times, whilst, after keeping this mixture for six days side by side with the pure water (*a*), the colonies in the latter exceeded those in the sewage tainted water almost 20 times. This result is probably analogous to the well-known experience that, in brewing, fermentation is shortened by the addition of yeast. At all events it proves the possibility that a sample in which many less colonies have been found than in another may be the more polluted.

(*c*.) The flasks in experiment (*a*) had been protected by ordinary plugs, which are known not to give invariable security against the penetration of microphytes. To exclude the possibility of any such error a number of pieces of 1-inch glass tubing, each about 3 inches long, were drawn out at both ends to a fine point, sterilised, and filled to about one-third with a water in which 27 liquefying, or a total of 290 colonies per c.c. had been found. The ends of the capillary tubes being sealed before the blowpipe, the samples were transferred to a cultivating chamber and kept at about 18° C. After six days the liquid in one of the tubes contained—on the average of four closely agreeing tests—8400 liquefying, or a total of 21,000, colonies per c.c. The liquefying colonies were, from the beginning, largely preponderating as compared with those in the first experiment, and after culture they were 40 per cent of the total colonies against about 0·1 per cent in the first experiment. This probably is the cause of the comparatively slight increase of other colonies. After a total of twelve days' culture the colonies showed a decrease to 1300 liquefying, or a total of 6400; and after twenty-two days to 880 liquefying, or 1700 total, colonies. After forty-four days' culture the liquefying colonies had decreased to 83, the total colonies being the same as after twenty-two days, viz., 1700. The experiment is being continued.

(*d*.) I have lastly traced the influence of storage, as indicated by the number of colonies, on the water in a clean slate cistern supplying my laboratory. During the

* Paper read before the Society of Medical Officers of Health, April 16th, 1886.

recent cold weather, when the New River water feeding the cistern had a temperature of 5° C., 17 liquefying, or a total of 49, colonies were found in it, whilst the water drawn from the cistern in the usual way, which had a like temperature, showed a total of 127 colonies per c.c., but no liquefying colonies. When the supply had reached a temperature of 11° C. it contained 37 liquefying, or a total of 880, colonies, whilst the water drawn from the cistern as above, having a temperature of 11½° C, contained 12 liquefying, or a total of 1544, colonies. The liquefying colonies had therefore under the circumstances decreased in both experiments, whilst the total colonies increased two to three times. I thought it interesting to ascertain, in connection with the above experiments, the relative bacteriological purity, or rather the number of colonies, when withdrawing water from the bottom of the cistern as above, with a tap of 2 feet higher up (about 2 inches below the top level). In some instances I obtained a very considerable increase of colonies at the bottom, in others an almost like increase at the top, and again in others no practical difference between the two samples; but the liquefying colonies were always, sometimes very considerably, in excess at the top. This behaviour probably depends essentially upon currents in the water when its surface is cooled by a depression of the temperature, and upon the relative quantities of water which are withdrawn from the top and bottom. The liquefying colonies appear to be more independent, selecting the top strata, perhaps on account of the oxygen there constantly absorbed from the atmosphere. The feed water was introduced in some experiments, as usual, at the top, in others at the bottom of the cistern: in the former case, contrary to my expectation, the colonies at the top showed the greatest reduction. It may not be without importance if these indications should lead to some simple mechanical arrangement, allowing of the withdrawal from cisterns of a water containing fewer microphytes than with our present appliances, as such reduction would be likely also to extend to any specific disease germs which may have entered the water supply.

The development of microphytes is lastly influenced by the proportion of free oxygen present, and of light or darkness. We know that the enormous microscopic growth in certain waters can be checked by exclusion of light. In order to keep the influence of light distinct from that of storage, parallel samples of water were mixed in the usual way with gelatin-peptone, spread on glass plates, and cultivated with and without exposure to light. When light was excluded the total colonies were, on the average of six experiments, reduced by about one-third as compared with the samples exposed to light. A distinct excess of colonies, when cultivating in darkness, was observed in one case only.

(3.) The preceding observations have laid a foundation upon which we may build up our argument concerning the reliability of the gelatin-peptone method as a hygienic water-test. Organic carbon and nitrogen, ammonia, nitric and phosphoric acid, chlorine, and other bodies met in potable water, have all in their turn been employed as analytical standards, because they point to something, or at least are supposed to point to something, which is or may be injurious to health. *The numbers of colonies, excluding for the present specific germs of disease, can likewise claim significance only if they bear in some way an invariable, or at least practically invariable, ratio to wholesomeness.* It must either be shown that they themselves follow a like rule as chemical poisons, being harmless in some numbers and hurtful in others, or, second, that they are an indication of something else which is injurious.

Absence of colonies, which happens but rarely, may safely be taken as a sign of exceptional purity, excluding at any rate recent pollution of a sample. A few colonies probably justify a similar conclusion, but we do not know where to draw the boundary. Taking the other extreme, as many as 770,000 microphytes per c.c., and may be many more, are evidently *per se* not necessarily an indication of unwholesomeness, otherwise this would have been observed on board ship, where water frequently has to be stored much longer than six days, and under much more unfavourable conditions than in my experiment. Should this argument not satisfy anyone, I can give still another. Mix the gelatin in one of your test-tubes with sterilised water, spread on a glass plate, and expose this for an hour to the air of your laboratory. The gelatin after culture will in all probability exhibit the appearance of what is assumed to be a very inferior sample of water, both in numbers and kinds of colonies. With every breath we draw in those microphytes, and, however pure water may be, we wash them down when we drink it. This again shows the impossibility of condemning a sample simply and solely because it contains a certain number of colonies, although this may exceed more than a thousand times the number ordinarily found in potable water. On the other hand, it is equally impossible to mark 770,000 colonies per c.c. as permissible, though specific germs of disease may be absent, for this would mean, as we have seen, that Thames water from London Bridge, or a sample actually mixed with 1 per cent of sewage, is, as far as bacteriological purity goes, very considerably within the boundary.

But the number of colonies ordinarily found in cultured samples of water may perhaps be an indirect indication of danger, being in some ratio to the liability of the introduction of pathogenic microphytes by polluting matter. Let us, then, enquire whether some of the conditions, at least, upon which we found the development of microphytes to depend, have an invariable connection with pollution.

Temperature, storage, and light have obviously no such connection whatever. Highly polluted waters are, as a rule, not as well aërated as pure waters; but if the deficiency of oxygen has, under the circumstances, at all an influence on the development of microphytes, it would check it. We would therefore find fewer colonies in a highly polluted water, or the reverse of what we ought to arouse our suspicion. Food, the only remaining link to establish a connection between the number of colonies and pollution, is unquestionably the result of the latter in the widest sense, but let me remind you that even the scanty traces of food in distilled water suffice sometimes for the development of comparatively very large numbers of microphytes. Practically speaking there is in this case no pollution whatever, and, going a step further, the "very good" sample of New River water contained a sufficiency of food for at all events as many as 770,000 colonies per c.c. If we take that quantity of food as an indication of so serious a pollution that we must condemn the sample, very few potable waters will remain which have not to be condemned, or, if we pass it over as insignificant, very few will not pass muster. How, then, are we to proceed? No doubt the number of colonies and food or pollution bear, perhaps in the majority of cases, a direct ratio to each other, but we have no means of knowing whether or not this holds good in any given case.

(4.) Although we may be unable to accept the number of colonies, in testing water indiscriminately, as the standard of either wholesomeness or pollution, that number may in a variety of enquiries give most useful and reliable indications, if applied judiciously. Some such instances have already been referred to, and they could be largely multiplied. But even in such a simple experiment as the purification effected by some filtering material, it is conceivable that the number of colonies found may largely be due not to a deficiency in the action of the material, but to its power of retaining water. It is not easy, under any circumstances, so to wash a filtering body that every trace of the water added, say, on starting the experiment, has been renewed. Unless the material is absolutely antiseptic throughout, any microphytes in the water so retained would at once start a multiplication

similar to that in the New River water kept for some days.

The flow of water supplies an abundance of food, and, a portion of the progeny being carried along with it, the filtered water may compare unfavourably as regards numbers of colonies, and yet these may be of as little significance as in those samples of New River water. Here, again, absence of colonies in the filtered water, or a very great reduction, give more conclusive indications than an increase.

If I as a chemist may venture to express an opinion on a purely biological subject, I would further mention that the vitality of some microphytes is apparently increased by the separation of others. The lowest forms of organisms have amongst themselves the same fight for supremacy, or existence, which we find amongst the highest. This is indicated by the experience of M. Pasteur, that the virus of hydrophobia loses its virulence when decomposition sets in. Dr. Koch is of opinion that bacteria of putrefaction may likewise exterminate the comma bacillus; and Prof. Arnaldo Cantani has had experience tending to show that inhalations of a rich culture of bacterium termo in gelatin are destructive to the tubercle bacillus. In this way considerable complications may arise, if we attempt to draw conclusions from the number of colonies, for, speaking under the correction of the specialists here present, the conqueror—if I may use that term—may be more prolific than the conquered microphyte. In that case a separation of the one can actually result in an increase of colonies; and if we assume, as in the above instances, that the conqueror is harmless, the conquered microphyte hurtful, such increase would mean an important sanitary improvement of the water.

(5.) A careful and systematic microscopic examination of the colonies found, which is scarcely within the province of a chemist, is an important aid in drawing conclusions from their numbers. Such examination is, however, incomplete without pure culture of the colonies in appropriate media. The controversy about the identity of Dr. Koch's comma bacillus is fresh in the memory of all who take an interest in such matters. Dr. Koch has told us that a precisely similar microphyte, as far as appearance under the microscope goes, was mistaken for the comma bacillus, and that the two can only be distinguished by the application of *three tests*, viz., the microscopic examination, and culture both in gelatin and on potatoes. This surely does not apply only to the comma bacillus, but also, more or less, to other microphytes, and the reliability of our conclusions appears the more diminished the less of the colonies present, in proportion to the total, can in the course of ordinary laboratory work be subjected to such rigorous tests. In extraordinary emergencies—say during an epidemic—hundreds, or even thousands, of colonies may be scrutinised by a staff of experts in the examination of a water; but even if all this has been done, I ask you, is our knowledge of the pathogenic microphytes, which are the cause of zymotic disease, sufficiently advanced to make sure that we may not pass over a culprit as harmless? The picking out by chance of some pathogenic microphyte would be important, but can scarcely satisfy the demands of hygiene, for amongst hundreds of harmless colonies a hurtful one of similar appearance may escape notice. Those pathogenic microphytes which cannot be cultivated in gelatin-peptone are entirely lost to observation, unless other cultivating media be employed. Another difficulty which occurred to me is, that the microscopes at present in use do not reach a large portion of the inner field of the cultivated plates. There important colonies may escape detection, and it seems desirable either so to alter the microscopes or the glass plates that the whole field of the latter can be scrutinised. Dr. Koch considers that the suspicion attaching to the numbers of colonies is enhanced if many different *kinds* are present, but I have not seen a single report containing a reference to this criterion, nor do I know how to apply it. It is not unfrequent that not even the numbers of liquefying, but only those of the total colonies are given.

(6.) The difficulties pointed out above would largely disappear if means or conditions could be suggested allowing of culture of pathogenic microphytes, more or less to the exclusion of others. For instance, some probably harmless microphytes do not thrive without light, whilst pathogenic microphytes cannot be dependent upon light, or the animal body would not be their favourite nidus. I have therefore proposed to Dr. Koch that it might be useful to take advantage of my experience herein referred to, and lay down the rule that all cultures in testing water be made with exclusion of light.

I confess I am one of those who based very sanguine expectations on the gelatin test, which I hoped would prove an important aid in the work I am engaged in. Great is my disappointment in finding myself unable to trust to it implicitly, the greater as I thus find myself in opposition to a man whose achievements in hygienic research stand as high as those of Dr. Koch. But were his time and thought not more than fully taken up by pathological work of the greatest importance to mankind, I feel assured he would long ago have advanced the same line of argument which I—I am afraid in a very imperfect manner—have placed before you this evening. As it is, I must draw the conclusion that the number of colonies ordinarily found in water has no necessary or invariable connection with wholesomeness or pollution. Such a connection may or may not exist in any given case, and we have no means of deciding whether the one or the other applies. The detection of pathogenic microphytes by microscopic tests, including pure cultures, would be of great importance, but is limited by our knowledge of those microphytes. In fact, although the test is most useful in special cases, I am of opinion that it requires development at the hands of biologists and pathologists before chemists can attempt to draw from it generally applicable conclusions. I have extended my enquiries for many months to regular reports on the Metropolitan water-supply, but unless fallacy can be pointed out in my experiments and arguments, which would give me the greatest satisfaction, I do not think it would serve any useful purpose to further continue them.

ON THE EXPLOSION OF HOMOGENEOUS GASEOUS MIXTURES.

By DUGALD CLERK, F.C.S.

EXPERIMENTS were made by Hirn in 1861 to determine the pressures produced by the explosion of mixtures of inflammable gases with atmospheric air. The pressures of the explosions were much lower than calculation gave, assuming that the maximum pressure of the explosion was coincident with the complete combustion of the gas. For a mixture of 1 volume of hydrogen and 9 volumes of air, calculation gave 5·8 atmospheres, whereas experiment only showed 3·25 atmospheres. Coal-gas behaved in a similar way. Bunsen's experiments, made in 1866, corroborated Hirn's results, and went a step further by proving that the heat was not all evolved, even when the vessel was completely filled with flame; that was, the deficiency of pressure was not due to the burning out of the flame at one part before ignition occurred in the other part of the vessel. More recently a series of papers had appeared describing numerous experiments by Messrs. Mallard and Le Chatelier, in all of which experiments a large deficiency of pressure was observed. Messrs. Berthelot and Vieille also supported their conclusions.

* A Paper read before the Institution of Civil Engineers, March 9, 1886.

The author had made the experiments described in this Paper, partly to obtain much-needed data for gas-engine work, and partly to study more fully the nature of the actions occurring during explosion. His experiments corroborated those of previous workers, in proving indisputably the existence of the limit to increase in pressure, the deficiency in pressure being very great, seldom more than one-half the heat of the explosion being evolved at the moment of maximum pressure. The explosion-vessel used by the author was a strong cast-iron cylinder, the internal space being 7 inches in diameter and 8¼ inches long. Upon the upper cover was mounted a Richards' indicator, from which the ordinary reciprocating-drum had been removed and a revolving one substituted, driven by a falling weight and suitable gear; a fan moving at a high velocity served as governor. The revolving-drum was enamelled, and a soft blacklead pencil, held by the indicator motion, marked upon it a line caused by the movement of the indicator piston. A pair of insulated points projected through a plug in the bottom cover and served to ignite the mixture when a spark from a coil and battery was passed between them. The line traced on the drum by the indicater showed the amount of rise in pressure, and the times of rise and fall in terms of revolution of the drum. The tracing was precisely analogous to the indicated diagram from an engine. The rising line was due to the explosion, the falling line was due to the cooling action of the cold walls upon the hot gases. The tracing was in fact a record of the rapidity, intensity, and duration of an explosion. Careful tracings were made, which were reproduced. Tables were given of the results obtained from various mixtures of air with Glasgow coal-gas, Oldham coal-gas, and pure hydrogen.

Glasgow Coal-Gas- and Air-Mixtures.

Temperature of Gas before ignition 18° C. pressure, atmospheric (14·7 lbs)

Expt.	Proportion of Gas by volume.	Mean Pressure. Lbs. per square inch above atmosphere.	Max. Temp. Centigrade. Degs.	Time of Explosion. Second.
a	1	52	1047	0·28
b	1/8	63	1265	0·18
c	1/10	69	1384	0·13
d	1/9	89	1780	0·07
e	1/8	96	1918	0·05

Oldham Coal-Gas- and Air-Mixtures.

Average Temperature of Gases before ignition, taken as 17° C. pressure, atmospheric (14·7 lbs.)

a	1/15	40·0	806	0·45
b	1/12	51·5	1033	0 31
c	1/11	60·0	1202	0·24
d	1/10	61·0	1220	0·17
e	1/10	78·0	1557	0·08
f	1/8	87·0	1733	0·06
g	1/7	90·0	1792	0·04
h	1/6	91·0	1812	0·055
i	1/5	80·0	1595	0·16

Hydrogen- and Air-Mixtures.

Temperature of Gases before ignition, 16° C. pressure, atmospheric (14·7 lbs.)

a	1/7	41	826 to 909	0·15
b	1/5	68	1358 ,, 1539	0·026
c	1/4	80	1615 ,, 1929	0·01

From these experiments the relative value of the different mixtures of gases for producing power might be calculated. In Glasgow-gas, the most economical mixture for non-compressive engines was 1 volume of gas to 11 volumes of air; Oldham-gas 1 volume of gas to 12 volumes of air. Comparing Glasgow-gas and Oldham-gas, the pressure of explosion of the former was longer sustained than that of the latter, and the pressures produced for a given volume were equally good; therefore, more power was obtained from a cubic foot in Glasgow than in Oldham. Pure hydrogen, which was very commonly thought to be the best, was shown to be the poorest. An engine which would indicate 10 h.-p. with coal-gas would not indicate more than 3·7 h.-p. with pure hydrogen. The author's results were in complete accord with those of previous experimenters on the question of the existence of a limit; in no case did the heat accounted for by the explosion pressure amount to more than 77 per cent of the total heat present as inflammable gas; in the majority of cases it was little over 50 per cent. In the author's opinion, no single theory previously stated accounted for all the phenomena of these explosion curves. Although all experimenters were agreed upon the fact of the deficiency of pressure, they differed upon the causes producing this result. Three theories had been propounded:—

Theory of Limit by Cooling.

This was Hirn's theory. It supposed that when explosion occurred a point was attained when the cooling effect of the enclosing walls was so great, that heat was abstracted more rapidly than it was evolved, and accordingly the combustion, although continuing, did not proceed with sufficient rapidity to prevent fall of pressure.

Theory of Limit by Dissociation.

This was Bunsen's theory, and was undoubtedly very largely true. The fact that no unlimited temperature could be attained by combustion was so conclusively established, both by science and by practice, that gradual combustion from that cause might be safely taken as occurring at the higher temperatures of gas-engine explosions. There was, however, a difficulty in applying it to all cases. In an experiment with Oldham coal-gas, when the maximum temperature of the explosion was 806° C., the apparent loss of heat was 65 per cent, while in an explosion with a maximum temperature of 1733° C. the apparent loss of heat was only 38 per cent.

With hydrogen mixtures the same thing occurred:—

Max. temp. 900° C., apparent evolution of heat 55 p.c.
,, ,, 1700° C. ,, ,, ,, 54 p.c.

If dissociation entirely explained the limit, then, as water and carbonic acid must be dissociated more at the higher than at the lower temperature, the deficiency should be greater at 1700° C. than at 900°. It was not so. Some other cause than dissociation must therefore be acting to check the increase so powerfully at the lower temperature. The problem was more complex than had been hitherto supposed.

Theory of Limit by the Increasing Specific Heat of the Heated Gases.

According to Messrs. Mallard and Le Chatelier, the specific heat of nitrogen, oxygen, and the compounds formed by combustion, increased greatly at the higher temperatures; dissociation acted only to a trifling extent below 1800° C. The heat of combustion was all evolved at the maximum temperature of the explosion; but as the specific heat changed, calculation from the specific heat at ordinary temperatures was erroneous. The deficiency of pressure was therefore a measure of the increased capacity for heat of the reacting gases. The crucial point of this theory was the supposition that combustion was complete at the maximum temperatures; if it could be shown that combustion was not complete, then the whole theory fell to the ground. The author's experiments seemed to him to prove conclusively that combustion was incomplete; this has been done by a study of the curves of the rates of cooling of various explosions.

Fuller account of the Phenomena during Explosion.

In the author's opinion no single cause explained the limit in all cases of explosion. The actions operating were much more complex than had been generally supposed. To him it seemed that much confusion had arisen through neglecting to distinguish properly between two

distinct and separate phenomena, which occurred during explosion. These phenomena were the inflammation or filling of the explosion vessel with flame, and the completion of the burning which was so originated. The explosion-curves with coal-gas showed some extraordinary features; in many cases an actual check seemed to occur in the rising curve, lasting for some time, followed by an increase of pressure, but at a slower rate than before the check. It was noticeable that the strongest mixtures showed it most distinctly. The hydrogen curves exhibited no such check. It seemed, then, that not only might combustion be incomplete when the vessel was filled entirely with flame; but the pressure at that time might not have attained its maximum, and might continue to increase rapidly after that point.

Why did the pressure again increase after the pause in the explosion curve? The author suggested what he considered a sufficient explanation. In an ordinary fire-grate, a flame communicated to the coal at one point gradually spread till the whole was incandescent. The solid coal might be every part of it burning, and yet a further accession of air would cause it to glow more brightly—that was, to increase in temperature. Explosions had often occurred in flour-mills and in coal-mines from the diffusion, throughout the air, of minute combustible particles of flour and of coal-dust. If present in suitable quantity a flame applied at one part caused an explosion. It by no means followed, however, that complete inflammation coincided with maximum pressure; the pressure might still increase.

In coal-gas explosions the flame had filled the vessel before any check occurred, and then the hydrocarbons decomposed, causing a pause, which gave way to increase when the hydrogen and carbon so liberated combined with the free oxygen. In all chemical combinations dilution caused slowness of action, and dilution during a reaction by the products formed made the last part of the action slower than the first.

Conclusions.

1. Messrs. Mallard and Le Chatelier's theory of increased specific heat of the gases—nitrogen and oxygen—at high temperature was, in the author's opinion, erroneous.

2. Dissociation probably occurred at the higher temperatures to a considerable extent, but it was not the sole cause imposing a limit to increase of pressure.

3. Combustion was very similar to other chemical actions, the first part of the reaction occurring rapidly, and proceeding with increasing difficulty as the combination approached completion.

4. The explosion vessel was entirely filled with flame before the combustion was complete.

5. The limiting causes acted after the flame had spread completely.

6. The limiting causes in weak mixtures were diminution in the rate of burning as the reaction approached completion, and consequent limits by cooling. Combustion caused the heat to be evolved at rates greater than, equal to, and less than, the rate of cooling.

QUANTITATIVE CHEMICAL ANALYSIS BY ELECTROLYSIS.

By THOMAS MOORE, Erdington.

The electrolytic method of separating and estimating metals is now so very generally employed that I venture to think the following details of some of the more important processes by myself will be useful to those chemists who practise this method of analysis.

Iron.—To the distinctly acid solution of the ferric sulphate or chloride add a solution of glacial phosphoric acid (containing 15 per cent. of the glacial acid), until the yellow colour completely disappears (in presence of only small quantities of free acid a white gelatinous precipitate appears, which, however, dissolves in the after process); then add a large excess of ammonic carbonate, and gently warm until a clear solution is obtained. On electrolysing the hot (70° C.) solution by a current equal to 1200 c.c. mixed gases per hour, the iron is rapidly and completely deposited at the rate of about 0·75 grm. per hour: the end of the decomposition is recognised by testing a portion of the solution with ammonic sulphide. Potassic sulphocyanide gives no reaction in presence of phosphoric acid. Aluminium, chromium, and manganese also give a clear solution by the above treatment, but no deposition; the two latter, however, may be precipitated from the remaining solution by sodic sulphide (the ammonic salt having no effect), first, of course, reducing the chromium which has been converted into a chromate by the current.

Cobalt and Nickel, treated as above, give excellent solutions for complete electrolytic deposition when used either hot or cold. If chromium is present the deposition has a remarkably brilliant appearance, which is quite characteristic.

Zinc, submitted to the same treatment, gives a clear solution, from which a current equal to 100 to 300 c.c. mixed gases per hour readily deposits the metal as a shining, coherent coating, which may be washed, dried, &c., without fear of oxidation. If excess of ammonic carbonate is added to a solution prepared by precipitating the solution by sodic phosphate, and dissolving this pre-precipitate in potassic cyanide, a solution is obtained which when electrolysed hot (80° C.) gives an exceedingly rapid and complete deposit. A current equal to 1000 c.c. mixed gases per hour is used. Zinc (also Ni and Co, and to a certain extent Fe) may also be quantitatively separated from its glacial phosphoric acid solution by a current equal to 1300 c.c. mixed gases per hour. Zinc is best deposited on a silver-plated electrode, since it is very difficult to dissolve the whole of it off a platinum one, even by boiling concentrated acids.

Iron, Cobalt, Nickel, Zinc.—When a solution containing the four metals is treated with phosphoric acid and ammonic carbonate, and then electrolysed the whole of them are completely deposited. Cr if present forms a soluble chromate, Mn is partially deposited as oxide on the opposite electrode, Al remains unaltered.

Manganese.—In all cases it is better to estimate this metal as oxide by deposition on the positive electrode, using slightly acid solution of the nitrate or sulphate: it is, however, interesting to note that a very large proportion of the metal may be successfully deposited as such by employing a neutral solution containing a large excess of ammonic sulphocyanide. A powerful current is necessary.

Copper, when met with in the course of analysis as recently precipitated sulphide, should be dissolved in potassic cyanide, and the warm (70° C.) solution, after addition of excess of ammonic carbonate, electrolytically decomposed. The deposition is exceedingly rapid and perfect.

Cadmium.—The electrolytic estimation of this metal is very similar to that of zinc, and may be successfully deposited from any of the solutions given for that metal. A weak current (40 c.c. mixed gases) readily deposits all metal from its glacial phosphoric acid solution, whilst zinc under similar conditions gives no deposit whatever.

Bismuth.—As is well known, the difficulty of obtaining a good deposition of bismuth is considerable, but by carefully attending to the following instructions really good and reliable deposits may be obtained:—Add sufficient tartaric acid to prevent the precipitation of a basic salt; then, after rendering the solution slightly alkaline with ammonia, add a considerable excess of glacial phosphoric acid, so that the solution has a strong acid reaction. The solution so prepared is first decomposed by a weak current (20 to 30 c.c. per hour), but as the decomposition proceeds a much stronger one may be employed (450 c.c. per hour).

The deposit, which at first appears as a loose powdery film, gradually assumes a metallic lustre and becomes exceedingly hard and compact.

Tin is easily deposited, either from its acid or alkaline glacial phosphoric acid solution.

Arsenic.—An attempt to estimate As as AsH_3, by electrolysing its acid solution in presence of a large quantity of zinc sulphate, catching the AsH_3 in U-tubes containing $AgNO_3$, getting rid of excess of silver by HCl, and titrating the As_2O_3 in the filtrate with iodine and starch, gave only approximate results.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Concluded from p. 203.)

The Analysis of Manure Salt.

At the request of some of the members Mr. Gladding read some notes on the analysis of manure salt:—

A sample of manure salt analysed by us about a year ago tested 42·10 per cent of potash. A second chemist making it over 43 per cent, a sample was sent to Dr. Jenkins for reference. He made it about 42·50. I wrote to him that we must agree better than that, and suggested that we repeat the work. The result of this further work was very curious. Though following the instructions adopted at Philadelphia most carefully, and doing the work personally, our results varied all the way from 42 to 43 per cent. We could neither agree with the other nor with ourselves. The only explanation I can give for this remarkable work is that I subsequently found that the manure salt contained a large amount of magnesia which was not precipitated by barium hydrate nor ammonium carbonate, but came down with the platinum precipitate and was only partially washed out by the 90 per cent alcohol. By washing with NH_4Cl solution, however, this sample gave me accurately agreeing duplicates of 42·20 and 42·23 per cent.

Another very curious illustration of the errors liable to occur in the estimation of potash is the following:—

I prepared a solution of platinum by precipitating on zinc, washing with boiling concentrated HNO_3, then dissolving in *aqua regia*, then evaporating to dryness to draw off free HCl. Five c.c. of this solution evaporated to dryness dissolved perfectly in alcohol, but on testing chemically pure KCl with it I obtained 102 to 103 every time. But washing the solution with NH_4Cl solution, the impurity, whatever it was, was washed out, and the results came down to 100 per cent; and further washing with NH_4Cl made no difference.

Nitrogen.

Mr. Chazal made an oral report for the Committee on Nitrogen. In the absence of the other members of his Committee he requested that another Committee be appointed on the Report of the Committee on Nitrogen, and on the method to be used in determining nitrogen during the next season. It was so moved and carried.

Committee: Chazal, Jenkins, and Wiley.

In the course of the discussion of methods of determining nitrogen, Prof. Wiley said, with regard to

The Kjeldahl Method,

Mr. President, it is probably true, as Daffert has suggested, that in the estimation of nitrogen by Kjeldahl's method the process goes on in the following way:—

(1.) The sulphuric acid abstracts water from the organic compounds.

(2.) The sulphurous acid produced by the action of the carbonaceous mass formed by the dehydration of the organic substance has a reducing effect upon the nitrogenous bodies present.

(3.) The decomposition products containing nitrogen which are finally formed are converted into ammonium compounds by the energetic oxidation produced by the permanganate of potassium. It is probable, however, that the use of this latter reagent is not absolutely necessary; but without it the duration of the heating with sulphuric acid and anhydrous phosphoric acid must be continued somewhat longer.

Dr. Jenkins has already called attention to the error which is produced in distilling the alkaline mass with zinc, due to the fact that the liberated hydrogen carried over a portion of the alkali mechanically. Pfeiffer and Lehmann recommend a simple apparatus to prevent this mechanical transportation of the alkali. They interpose in the path of the distillation tube a platinum comb surrounded with fragments of glass, which they claim stops and holds the alkali. It is also possible that if the alkali employed contained a trace of nitrate, the action of nascent hydrogen upon it would result in the formation of ammonium, and thus a total amount of ammonia obtained might be greater than that in the original sample. The method of Wilfarth, as already suggested by Dr. Jenkins, does away with the necessity of the use of zinc. By the addition of mercury the time required for heating with the sulphuric acid in some cases was reduced to thirty minutes. Wilfarth states that only in one case was he troubled by the bumping of the liquid during distillation, and never when potassium hydrate is used instead of sodium.

Methods to be Used during the Next Year.

On motion of Prof. Wiley the Report of the Phosphoric Acid Committee was approved, and the method and recommendations proposed by them were adopted.

Dr. Dabney moved that the next Committee on Phosphoric Acid be instructed to request the chemists to whom they send test-samples to make the determinations of water soluble and citrate insoluble (citrate soluble indirectly) during a particular week to be named by the Committee. Carried.

On motion of Mr. Chazal the Report of the Potash Committee was approved, and their method and recommendations were adopted for the next season.

Prof. F. W. Clark, by request of the members, gave a brief discussion of the atomic weight of platinum. He said, in addition, that he washed the Pt_2 precipitate on an ordinary filter, and washed it through into a Pt capsule, in which it can be dried at any temperature.

The Committee on the Report on Nitrogen submitted the following, which was adopted:—

The Committee appointed to consider the Report of the Committee on Nitrogen beg to report that the returns from the samples sent out by the Committee were so few and meagre, and the discrepancies so large, as to make it inadvisable to recommend any method for the determination of nitrogen for use during the next season, and recommend that the entire Report of the last Committee be referred, without further action, to the next Committee on Nitrogen.

P. E. Chazal, Chairman.
E. H. Jenkins.
H. W. Wiley.

This Report was adopted.

Prof. Wiley, said, in this connection,—

Mr. President, I suggest to the next Committee on Nitrogen that in sending out samples for analysis during the next year they include some of chemically pure compounds in which the percentage of nitrogen is definitely known, and that they suggest to the analysts receiving the samples that they first try their apparatus, reagents, and chemicals on these known samples before beginning with the unknown. Having proved the reliability of their manipulation, they will be better satisfied with their results obtained on bodies of unknown composition. I

* From the *Proceedings* of the Second Annual Meeting of the Association of Official Agricultural Chemists, at Washington, D.C., September 1, 1885. Edited by Charles W. Dabney, Jun., Ph.D., North Carolina Agricultural Experiment Station, Secretary.

suggest also that the same course be followed by the other Committees of the Association.

Dr. Dabney added to this suggestion that the Committee send out for test-analyses selected organic nitrogen compounds of well-determined composition, and which can be obtained in perfect purity (well crystallised) to represent various per cents of nitrogen in its several relations in amido, imido, nitro, nitrose, and cyanogen, &c., compounds.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 15th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Mr. H. R. G. Bamber was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Edwin Jennings Ball, Ph.D., 15, Trafalgar Square, Chelsea, S.W.; Parvathi Nath Datta, 5, West Newington Place, Edinburgh; Robert Elliot Dorán, Bray, Co. Wicklow; Richard Dormer, Garstan; William Edward Dawson, Pretoria, Transvaal, South Africa; William Dobinson Halliburton, 135, Gower Street, W.C.; John Tysilis Johnson, Glyn Hof, Conway; William Selby Simpson, 95, Darenth Road, Stamford Hill, N.; Henry H. Walker, 35, St. Tham Road, Fulham, S.W.

The following were elected Fellows of the Society:—

Messrs. E. E. Burnett; Cosmo J. Burton; Carl Bennert; Ph.D.; Arthur W. Clayden; Christopher Hodgson; John W. King; Charles Kilpatrick; Arthur R. Ling; Henry O. Mintz; Frank Morel; Robson Roose; Richard Ll. Whiteley.

Mr. R. J. Friswell exhibited a very large specimen of metatolylene diamine, $C_6H_3Me(NH_2)_2$.

The following papers were read:—

41. "*The Eurhodines, a New Class of Colouring Matters.*" By Otto N. Witt, Ph.D.

By acting with orthoamidoazo-compounds on α-naphthylamine hydrochloride, new dye-stuffs may be obtained, which have received the name of *Eurhodines*. The typical eurhodine, prepared from amidoazotoluene and α-naphthylamine, crystallises in orange needles. Its solution in ether is yellow, and shows a brilliant green fluorescence. Its salts are of a scarlet colour. The formula of eurhodine is $C_{17}H_{13}N_3$. By the action of acids it is transformed into eurhodol, $C_{17}H_{12}N_2O$, whilst ethylic nitrite produces the ethylic ether of eurhodol, $C_{17}H_{11}N_2OC_2H_5$. Eurhodine is recognised as amidonaphthylenetoluquinoxaline. A large number of eurhodines may be obtained synthetically by the action of orthodiketones on triamines which have two of the amido-groups in the ortho-position. The substance $C_{20}H_{13}N_4$ formed by the action of phenanthraquinone on 1 : 2 : 4 triamidobenzene has been examined and found to resemble closely the typical eurhodine. The joint oxidation of orthotoluylenediamine and α- and β-naphthol has been studied. α-Naphthol produces a blue dye belonging to the indophenol group, while β-naphthol gives rise to the formation of a new naphthalenetoluquinoxaline. As only two of these are capable of existence, the new compound must be the β-β-isomeride.

42. "*The Action of Sodium on Ethereal Salts of Phenylacetic Acid.*" Part II. By W. R. Hodgkinson.

In this communication the author principally draws attention to the solid substance produced in small quantity by the action of sodium on ethylic phenacetate (phenylacetate) to which reference was made in the previous paper (*Trans.*, 1880, 480).

The products of the reaction were stated to be ethylic acetate; an oil to which the formula $C_{18}H_{20}O_3$ was provisionally given; phenylacetic acid; and the solid body in question, The reaction was represented as occurring between 6 mols. phenacetate and 2 atoms of sodium; but it is difficult to dissolve so large a proportion of sodium without heating too strongly, and it is better to use 8 mols. phenacetate to 2 atoms of sodium.

On examining larger quantities of the oil to which the formula $C_{18}H_{20}O_2$ was given, the author finds that it is not a uniform substance: it decomposes into substances of high boiling-point—water being given off—even when distilled under reduced pressure. If the crude product be hydrolised by means of alcoholic potash, it yields phenacetic acid and a more stable oil; this oil principally consists of a substance which boils at 320° to 325°, and has the composition of dibenzylketone: such a ketone would result from the hydrolysis of ethylic phenacetophenacetate, $Ph.CH_2.CO.CHPh.COOEt$.

The solid substance produced simultaneously with the oil is represented by the formula $C_{24}H_{18}O_3$. It is not an acid, although it is obtained in solution apparently in the form of a sodium-derivative on heating the crude product of the action of sodium with water; but it is easily precipitated from this solution even by absorption of atmospheric carbon dioxide. It is almost insoluble in water, and has no action on test-paper; the aqueous solution, however, gives a deep-red colouration with ferric chloride. It dissolves in strong solutions of potassic carbonate without carbon dioxide being evolved, and also in dilute alcoholic potash; it slowly dissolves in sulphuric acid, and is re-precipitated by water if the acid be not heated. It reacts with ammonia and with hydroxylamine. It is unaffected by heating with water at 210°. It is oxidised with difficulty, and yields a product which is not an acid. It melts at 175°; the fused substance solidifies to a glassy mass which softens at 100° and then assumes a crystalline state, and melts as before at 175°.

The author is of opinion that this substance results from the occurrence of a reaction similar to that recently observed by Baeyer in the case of ethylic sodiomalonate, and that, in fact, it is a *triphenylphloroglucin*,—

$$(C_6H_5)_3C_6H_3O_3,$$

three molecules of ethylic sodium phenacetate condensing to form triphenyltrisodiophloroglucin, three molecules of alcohol being eliminated.

If sodium act at a temperature of 140° to 150° on an excess of ethylic phenacetate, ethylic phenacetophenylsodacetate is produced.

The author has also examined the action of sodium on the ethylic salts of the toluic acids: the para- and meta-compounds appear to undergo a complex decomposition, but the ortho-compound yields ethylic acetate and a ketone, $C_{14}H_{10}O$.

43. "*The Action of Metals on Acids.*" By Henry E. Armstrong.

Our knowledge of the nature of alloys is at present very limited: it is supposed that some metals are capable of combining, but that others form mere mixtures when fused together, the alloy being, as it were, "a solidified solution of the one metal in the other." This differentiation is based on the study of physical properties of alloys in comparison with those of the constituent metals. In certain cases—but these are very few in number—the actual composition of the compound may be deduced:—thus in the case of the tin-copper alloys abrupt changes in electrical conductivity correspond to compounds of the formula $SnCu_4$ and $SnCu_3$, and the curve of conductivity for the tin-gold alloys also exhibits a striking series of maxima and minima from which the existence of definite compounds may be inferred. It appeared possible that, by dissolving alloys in a liquid capable of acting on both metals and determining the electromotive force between the alloy and a less positive metal, evidence of the existence of definite compounds might be obtained if the alloy

dissolved as a whole. At Dr. Armstrong's suggestion a number of determinations of this kind have been made by Messrs. Holland Crompton and W. E. Sumpner, students of the Central Institution, but the investigation is as yet far from being completed; they have measured the E.M.F. between the alloys and platinum in nitric acid by means of an electrometer. The general result is that the method is inapplicable, since the alloys do not as a rule behave as wholes. The E.M.F. observed in several cases is very nearly that between the less positive metal of the alloy and platinum, the more positive constituent dissolving independently and giving rise to a local circuit: thus in the case of copper-zinc alloys the E.M.F. is very nearly that of copper as long as the alloy contains not much less than about 5 per cent of copper; the tin-zinc and tin-copper alloys also have an E.M.F. near to that of the less positive metal until alloys are reached containing but a small proportion of this constituent. In mercury-zinc alloys the more positive metal determines the electromotive force: this apparently is also true of the lead-tin alloys. Slight changes have been observed which, if confirmed by further experiments, are probably significant: thus in the tin-zinc alloys the E.M.F. gradually rises from that of tin as the amount of this metal in the alloy diminishes: it is conceivable that this may be because the zinc acts as a diluent, and separates the more complex tin molecules into simpler more active molecules. On the other hand, the E.M.F. of copper in bronze is slightly lower than that of pure copper, and that of copper in the copper-zinc alloys rich in zinc is also a little lower than that of pure copper: this may be due to the loss of energy in the formation of the alloy.

Dr. Armstrong then pointed out that although the method described was of little value, owing to the irregularity in the behaviour of alloys towards a solvent capable of attacking both metals, more was to be hoped from the employment of a solvent capable of acting upon only one, recent experiments by Mr. Laurie having shown that the E.M.F. between zinc copper alloys and cuprous iodide in a solution of iodine and zinc iodide is about that of zinc until the alloy has the composition $CuZn_2$, when the E.M.F. suddenly falls to very nearly that of copper. Sodium and potassium exhibit a much lower E.M.F. when alloyed with mercury, according to Hockin and Taylor, and it is probable that the examination of a graduated series of their amalgams will afford indications of the composition of the compounds formed.

The E.M.F. between a given metal and platinum in nitric acid varies with the concentration of the acid. The following results were obtained with copper:—

Acid of rel. den. 1·5	E.M.F.	0·98 volt.
3 vols. 1·5 + 1 vol. 1·42 ..	,,	0·84 ,,
1 vol. 1·5 + 1 vol. 1·42 ..	,,	0·63 ,,
1 vol. 1·42	,,	0·57 ,,
1 vol. 1·42 + 1 vol. water	,,	0·75 ,,
1 vol. 1·42 + 3 vols. ,,	,,	0·81 ,,
1 vol. 1·42 + 7 vols. ,,	,,	0·81 ,,

These results appear to be entirely confirmatory of the conclusions already arrived at by Ackworth and Armstrong (*Trans.*, 1877), who found that the reduction of nitric acid was carried further—as indicated by the amount of nitrous oxide and nitrogen produced—when copper is dissolved in highly diluted nitric acid. The high E.M.F. observed on using the most concentrated acid is probably due to the fact that the initial product of reduction, nitrous acid, remains in solution. If the acid be less concentrated the nitrous acid is more or less broken up—

$$(3HNO_2 = 2NO + HNO_3 + H_2O).$$

The considerable rise in E.M.F. as dilution proceeds not improbably arises from the complex molecules of nitric acid being in part resolved into simpler more active molecules. The results also illustrate the importance of supplementing the chemical method of examining complex cases of change such as are involved in the action of metals on nitric acid by the electrical method. No appreciable action takes place during the time requisite to measure E.M.F., and therefore the solution remains practically unchanged in composition, whereas it is continously changing during the entire course of a chemical experiment.

Referring to the action of metals generally on acids generally, Dr. Armstrong pointed out that it is probably impossible for the chemist to pronounce definitely in favour either of the modern view that the metal directly displaces the hydrogen of the acid, or of the older view that the metal displaces the hydrogen from water—the resulting oxide and the acid then interacting to form a salt: the decision of this question must apparently depend upon the determination of the nature of the phenomena during electrolysis of an acid solution. If the acid alone be the electrolyte, then doubtless the modern view is the correct one; but if both water and acid are electrolysed, and in proportions which vary according to the conditions, then both the old and new view of the nature of the action between a metal and the solution of an acid are correct, and the two kinds of change may go on side by side. The view put forward by Dr. Divers, that silver, copper, and mercury exercise an altogether peculiar action on nitric acid, "decomposing the nitric acid into hydroxyl and nitroxyl, and combining with these radicles to form hydroxide and nitrite, which, by secondary reactions, become water, nitrous acid, and metal nitrate," does not appear to be compatible with the view that the interaction of a metal and an acid is essentially a case of electrolysis, there being no reason to suppose that nitric acid can be electrolysed into hydroxyl and nitroxyl; it is not supported by the observations here described on the E.M.F. of copper in acids of various strengths, which show that more depends on the state of the acid than on the metal; and, lastly, silver is incapable of acting on nitric acid, although it readily enters into interaction with the weaker electrolyte, nitrous acid.

NOTICES OF BOOKS.

Watts' Manual of Chemistry, Theoretical and Practical. (Based on Fownes' Manual.) Vol. II., Chemistry of Carbon Compounds, or Organic Chemistry. Second Edition (Thirteenth Edition of Fownes'). By W. A. TILDEN, D.Sc., F.R.S.. V.P.C.S., Professor of Chemistry in the Mason College, Birmingham. London: J. and A. Churchill.

THIS book is a case of compound authorship. To decide with whom the especial responsibility of its merits or demerits must rest might prove very difficult; but that good features must very largely predominate may be very safely concluded in a manual which has passed through the trying ordeal of thirteen editions, and which has earned the favourable opinions of so many teachers. It has been Prof. Tilden's object, as he informs us in the preface, to avoid any needless increase in the bulk of the work, but he considers that it will nevertheless be found to contain all carbon compounds of either theoretical interest or practical importance. This opinion is, in the main, perfectly justified. If there is any section of the work in which we might suggest any modification it is in the account of the coal-tar colours, which is scarcely on a level with the knowledge of the present day. The alizarin group, however, is described as fully as the limits of space permits.

With reference to picric acid, we may remark that text-books of much larger bulk than the one before us, overlook the fact that the yellow stains produced by nitric acid upon the fingers are due to the superficial formation of picric acid.

The notice of cellulose is on a level with the most

recent researches, save that we find no mention of oxycellulose.

Taking the work as a whole, we can by no means wonder at its success. The production of a text-book of manageable compass, clear in its arrangement, giving so much that is essential, and eschewing what is, for the present at least, of secondary value to the student, has been a task no less useful than difficult.

Report of Experiments on the Growth of Wheat for the Second Period of Twenty Years in succession on the same Land. By Sir J. B. LAWES, Bart., LL.D., F.R.S., and J. H. GILBERT, LL.D., Ph.D., F.R.S. London: W. Clowes and Co., Limited.

WE find here a summary of an important part of the far-famed experiments which have for such a length of time been carried on at Rothamsted. It appears that in this case a soil, which in the ordinary course would have received a dressing of manure every season before another crop has grown, has yielded forty successive crops of wheat averaging 14 bushels per acre. The organic nitrogen which at the outset existed in large amount has been of course much reduced. The most important mineral plant-foods, potash and phosphoric acid, have also greatly diminished in quantity. The residual stock, however, is estimated as being still sufficient to grow wheat for a very considerable time, though the crops will gradually become less plentiful.

From experiments with manures, the authors find that, at least as far as wheat is concerned, mineral manures alone add but slightly to the produce grown upon unmanured land. The amount of nitrogen supplied in manures is very greatly in excess of the quantity recovered in increased crops. After a certain point has been reached each further increase of crop requires a proportionately heavier dressing of manure.

As regards unexhausted manures it appears that potash and phosphoric acid form insoluble compounds remaining in the soil and remain available for future crops. Such is not, however, the case with excess of nitrates or ammoniacal salts, as they are washed out by rain or otherwise lost.

Water-Analysis: a Practical Treatise on the Examination of Potable Water. By J. ALFRED WANKLYN and ERNEST THEOPHRON CHAPMAN. Sixth Edition, by J. ALFRED WANKLYN, M.R.C.S. London: Trübner and Co. 1884.

WE have here the most recent addition of a work which has had a most important and upon the whole a favourable influence upon the analysis of water.

As it will be seen by all who have the opportunity of collating all the successive editions, the treatise has undergone certain modifications. The fifth edition, bearing date 1879, contained, like the one now before us, an account of the so-called "moist combustion process," devised, as we are told, by the author and by his "friend Mr. Cooper." This process the inventors have taken the "very unusual," or, as we believe it might be said, the unprecedented, step of patenting. We have on a former occasion expressed our opinion of this transaction, which further consideration has by no means led us to modify. Until 1893 the process is protected against practical criticism and possibly against general adoption. We may indeed ask what would be the condition of analytical chemistry and of "the chemical profession in this country" if this practice were to become general?

Among the matter not to be found in the earliest editions is an account of the water of the Nile, founded upon samples received in 1874 and 1875. The most remarkable point brought out in these analyses is the great annual fluctuation in the proportion of chlorine.

A very striking feature in this edition, as compared, *e.g.*, with the third, is the appearance of certain polemical matter under the title "History of the Ammonia Process of Water-Analysis; and Controversies on Water-Analysis." Whatever may be the rights or the wrongs of this question we have grave doubts as to the policy of thus continually obtruding it upon the chemical public, so many years after the events. Nothing more rapidly finds its level than an analytical process, unless, indeed, it is patented.

A very important addition to the present edition, as compared with the fifth, is that entitled "Verification." Mr. Wanklyn advises that the analyst should satisfy himself that his solutions are in order and his apparatus sufficiently clean by experimenting with distilled water, with the Kent Company's water, or with water filtered through a "silicated carbon" filter. As a further verification he recommends the preparation and analysis of an artificially prepared water containing a known quantity of nitrogenous organic matter, the results actually obtained being compared with the calculated impurity. This proposal is eminently rational and involves no practical difficulties.

In all other respects this latest edition possesses the same merits which have been recognised in its predecessors.

Milk Analysis: a Practical Treatise on the Examination of Milk and its Derivatives, Cream, Butter, and Cheese. By J. ALFRED WANKLYN, M.R C.S. Second Edition. London: Trübner and Co. 1886.

THIS edition differs very little from the first, which appeared as far back as 1873. The author does not adopt certain modifications of his original process, often regarded as improvements. Among these alterations are the proposals to dry for six hours instead of for three or three and a half hours; the suggestion to mix the milk with sand or to spread it out on blotting-paper; the proposal to resort to the Soxhlet digestion with ether, &c. In this work, and in a letter which he addressed to the CHEMICAL NEWS, vol. liii., p. 70, the author suggests that these "improved" methods may involve partial decomposition of some of the substances present. In view of the extremely complex composition of milk, concerning which the last word has by no means been said, we are inclined to suspect that such may be the case.

A fairly complete notice of the article known as butterine, oleomargarine, &c., and of its determination when in admixture with genuine butter might have been usefully added.

In this book, and in its companion volumes on "Tea, Coffee, and Cocoa Analysis" and on "Bread Analysis," we notice a defect for which not the author but the publishers must be held responsible, viz., the absence of lettering on the back. The volumes are of course too thin to admit of the titles being printed across the backs, but they might be lettered lengthways, as is often done. For want of this simple addition the books are very apt to be lost sight of on the library shelves, or at least not to be found except after much loss of time.

Tea, Coffee, and Cocoa: a Practical Treatise on the Analysis of Tea, Coffee, Cocoa, Chocolate, Mate, (Paraguay Tea), &c. By J. ALFRED WANKLYN, M.R.C.S. London: Trübner and Co.

THIS volume bears the date 1874, and is not stated to be a second edition. The author discusses in succession the determination of the ash in tea, of the aqueous extract, the determination of "free and albumenoid" ammonia in the extract of tea; the estimation of total nitrogen, of theine, and of tannin.

Mr. Wanklyn then proceeds to give a similar account of coffee, cocoa, and chocolate. As regards coffee his attention is more largely taken up with the numerous adulterants which have been more or less in vogue for the last century. The author's opinion that "the

mixing of chicory with coffee is really demanded by public taste," should be qualified by an admission that this taste has been artificially created by dealers for their own ends. Further, if the public prefer chicorised coffee this is no justification of the sale of a mixed article in which the cheaper ingredient largely predominates. In France those consumers who prefer the mixed decoction buy coffee whole and often even unroasted, roast and grind it as wanted, and add such a proportion of chicory as their taste dictates. Of all the trade-falsehoods of the day "coffee as in France" is perhaps the most glaring.

A notice of the kola-nut and of its dietetic value might be fitly added to this work in the event of a second edition.

In the preface we notice a polemical passage which, however justifiable it may have seemed in 1874, will now fail to be understood by many persons who may have forgotten or have never heard of the circumstances referred to.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 14, April 5, 1886.

On the Cerium Tungstates and Chlorotungstates.—P. Didier.

New Method of Preserving and Economising Hops Destined for Use in Breweries.—Louis Bouté.

No. 15, April 12, 1886.

Certain Singular Spectroscopic Phenomena.—A. Ricco.—On March 9 of the present year, with a refractor of 0·25 metre aperture and a direct-vision spectroscope each with two systems of 5 prisms, as the author was observing on an exceedingly brilliant protuberance the inversion of the rays D_1 and D_2, he perceived with surprise that the chromospheric ray D_3 which was very bright appeared double, being divided by a very fine black line. This observation was made with the slit of the spectroscope tangential to the margin. On turning the spectroscope round 90° the phenomenon was produced over the entire height of the protuberance. The same thing was seen still more easily in the chromospheric rays C and F. The author repeated these observations on the following days in various conditions of the sky. He has repeated them also with the diffraction spectroscope in the ray C and with spectra of from the first to the fifth order, where the dispersion is almost equal to that of the refraction-spectroscope.

Thermo-Electric Properties of Some Substances.—G. Chaperon.—The author has examined a number of combinations on account of their possible application to thermo-electric generators.

Density and Compressibility of Gases and Vapours.—Auguste Charpentier.—The compressibility of atmospheric air approaches that of nitrogen.

Transformation of Chromium Monochloride into the Sesquichloride. Molecular Conditions of Chromium Oxide.—M. Recoura.—The author has studied the heat of the conversion of anhydrous chromium monochloride into anhydrous chromium sesquichloride, and finds it to be + 39·4 cal. Chromium oxide precipitated from the sesquichloride and that from the oxychloride are not in the same molecular conditions. The former combines with 3 mols. of hydrochloric acid, but the latter with 2 mols. only. The first mentioned oxide can be dissolved and brought to a final state by 9 mols. of soda, whilst the latter requires 3 only. The oxide thus modified, whether derived from the sesquichloride or the oxychloride, combines only with 2 mols. of hydrochloric acid.

On Certain Chlorised Ethers.—L. Godefroy.—The monochlorous vinylethylic ether which the author has discovered has enabled him to prepare six other ethers, which form two distinct series having general characteristic properties almost opposite. The vinethylic ethers are colourless, not fuming on exposure to air, of a sweet penetrating odour, becoming more aromatic as they contain more chlorine. They distil without decomposition. If poured into ammoniacal silver nitrate they do not form a precipitate of silver chloride, but are reduced with formation of a mirror. The ethylic ethers fume in the air; their odour is irritant, but it becomes less so and more aromatic as they contain more chlorine. They are partially decomposed on distillation. If poured into ammoniacal silver nitrate they give an abundant precipitate of silver chloride. On boiling they are reduced, but they do not in general give a silver mirror.

Isomeric Naphthyl-phenyl-carbonyls.—M. Rospendowski.—The α-compound forms crystalline colourless transparent grains of a bright lustre. Its melting-point is 75·5°. The β isomer forms long white silky needles, melting at 82°.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 5, March 5, 1886.

Substitution of Pyrites for Sulphur in the Manufacture of Sulphuric Acid and the Improvements effected in their Combustion.—M. Scheurer-Kestner.—The use of pyrites in place of sulphur was originally due to Michel Perret, of Lyon. The same inventor has now succeeded in constructing a furnace which burns smalls better than lump pyrites, and in certain works the lumps are reduced to powder for use. At the Maletra Works, at Petit-Quevilly, the burnt ore now retains only 0·6 to 0·8 per cent of sulphur, and is sold as an iron ore.

Phenyl-mesitylene Carbinol and its Principal Ethers.—E. Louise.—The author describes the preparation of phenyl-mesitylene-carbinol, its ordinary ether, its mixed ethylic ether, the acetic and the benzoic ethers.

Detection of Acid Magenta and of Ordinary Magentas in Wines by the Use of Metallic Oxides.—P. Cazeneuve.—Already noticed.

Conditions of Formation of two Crystalline Nickel Arseniates, and on their Molecular Constitution.—M. Coloriano.—The author obtained a crystalline compound by precipitating 5 c.c. of a solution of nickel nitrate containing 1 grm. of the salt with 5 c.c. of a solution of sodium triarseniate containing 0·5 of the salt, adding 35 c.c. of water, and heating to 235° to 260° for six hours. The crystals when freed from amorphous arseniate contained about 3·5 per cent of water which was not entirely expelled below a red-heat. They form pale green hexagonal prisms, isolated or in groups, very hard and not readily attacked by acids, aqua-regia, and caustic potassa, either cold or hot. They dissolve readily in hydrochloric acid diluted with an equal volume of water at 180° in a sealed tube. A second nickel arseniate formed on heating arsenic acid to 225° to 240° with an excess of nickel carbonate forms green hexagonal plates and contains 7·33 per cent of water.

Russian Chemical Society.—Session March 7/19, 1885.—M. Kleber gave an exposition of the present state of our knowledge on the chemical composition of the heavenly bodies. The various kinds of heavenly bodies do not present an accidental agglomeration of the various elements of which they are composed. These elements possess, on the contrary, certain properties in common determined by their place in the periodic system. All elements of low atomic weights occur in the heavenly bodies with the sole exception of boron. Among the

other elements only the readily fusible metals are there distributed. The meteorites contain neither zinc nor boron, and in them lead is the only representative of the heavier metals. The analogues of iron are widely distributed in nature; the elements of the platinum group, on the contrary, have not been discovered in any of the celestial bodies hitherto examined. The author added a critical examination of the hypothesis of Lockyer on the dissociation of the elements, contending that it is by no means proved by the facts cited on its behalf by the English savant.

M. Reformatsky sent in a paper on the preparation of the polyatomic alcohols and their derivatives by means o hypochlorous acid.

M. Saytzeff communicated a notice of the synthesis of tertiary alcohols, setting out from the acetones.

M. Shalfeef sent in a memoir on the action of ammonia upon hæmine. The crystals of hæmine treated with an alcoholic solution of ammonia are decolourised, but preserve their crystalline form. They lose their power of double refraction. On the other hand, the brown crystals deposited by the ammoniacal solution are more strongly birefringent than the hæmine itself. The ahthor names the brown crystals hæminic acid, and the residue, insoluble in ammonia, heminostromine.

M. Sabaneff sent in a paper on the preparation and polymerisation of monobromised acetylene.

M. Menschoutkine presented some additional remarks on his work on the formation and decomposition of the amides and the anilides.

M. Loubavine described his experiments on the action of methyl iodide on carbylamine.

According to M. Ordinsky in the volumetric determination of phosphoric acid by means of uranium salts the tincture of cochineal can be used as an indicator. In presence of acetic acid the neutral uranium salts produce in the solutions of cochineal a very characteristic deep green colouration.

M. Favorsky has studied the transformations of the acetylenic carbides.

M. Kondakoff spoke of the action of chlorine upon trimethylethylene and announced that he had undertaken the study of the action of dry chlorine upon isopropylacetylene at $-20°$.

M. Solonina sent in a memoir on the action of dilute acids upon allylic alcohol.

M. Kjander submitted remarks on the correction of thermo chemical data with reference to the contraction of solids and liquids.

The third part of the Society's *Journal* contains a memoir by M. Przibytek on allyl dioxide.

Session April 4/16, 1885.—M. Lidoff sent in the results of his analysis of the ammoniacal waters from Siemens's boilers, heated with turf.

M. Lubavine gave an account of experiments on the action of heat upon a mixture of acetylene and hydrocyanic acid. The formation of pyridine in this reaction, as found by Mr. Ramsay, was not confirmed.

M. Krakau communicated his researches on the action of caustic alkalies upon cinchonine in presence of superheated steam. Among the products he isolated a viscous oil, acting upon light, and two inactive bases, quinoleine and lepidine.

M. Goldstein announced that he had undertaken researches on the capillarity of saline solutions.

M. Nikolukine sent in researches on lead tetrachloride obtained by acting upon lead peroxide in the cold with hydrochloric acid, and separating the tetrachloride from the dichloride, simultaneously formed by means of potassium and ammonium chlorides saturated in the cold, in which liquid the tetrachloride is readily soluble.

M. Potilitzine made a remark on the relation between the initial speeds and the formation-heats of salts.

M. Tcheltzoff communicated researches on the formation-heat of lead peroxide.

Session May 9/21, 1885.—M. Lwoff announced that according to experiments begun by Bougaieff, and continued by Wolkoff, secondary butylic alcohol, contrary to the statement of De Luynes, is not decomposed when heated for eight to sixteen hours to 240° to 250° in a sealed tube.

M. Roubtzoff, on passing ammoniacal gas into tubes filled with pulverised succinimide, and cooled down to $-10°$ and 20°, and afterwards sealing these tubes and heating them to 100° to 200°, has succeeded in fixing the ammonia and converting the contents of the tube into succinamide.

Mdlle. Roundinskaia has effected the dissociation of ammonium parabanate and its transformation into oxaluramide.

M. Menschoutkine presented to the Society two memoirs—"Data to serve for the Comparison of Theories of Substitution and of Structure," and "On the Isomerism of Benzol Derivatives."

M. Kanonnikoff has undertaken researches on the azo-compounds with mixed and substituted radicles and their derivatives.

M. Barzillovsky sent in a note on researches on the reaction of azobenzene and of benzoic aldehyd.

M. Alexeeff has studied the reciprocal solubility of secondary butylic alcohol and of water; the curve of solubilities presents two maxima and two minima; at 107° the two liquids become miscible; *b*, the solubility of salicylic and benzoic acids, and of phenol in the solid state; *c*, the phenomena of the solution of metals in a state of fusion; he finds that the vapours of many metals (*e.g.*, zinc and silver, silver and bismuth) dissolve each other mutually; the liquidation of alloys is explained by the decomposition of solutions in consequence of cooling.

M. Sorokine made a remark on the formation of lactic acid by the decomposition of levulose by means of the caustic alkalies and baryta.

M. Przibytek is studying the addition-products of bromine and hydrocyanic acid to allyl dioxide.

MM. Przybytek and Tamintzin have analysed the ash of the pollen of the Scotch fir. It contains 29 86 per cent of phosphoric anhydride.

M. Diaconoff proposed a new method of determining the combustion-heat of solid organic compounds not readily combustible, consisting in burning them along with glycerin and powdered asbestos.

M. Mikhailoff effects the separation of the globulines and the albumenoids of blood serum by saturating the liquid with crystalline ammonium sulphate finely powdered.

M. Goldstein observes that a solution of calcium chloride in passing through a capillary tube becomes less concentrated.

M. Konovaloff described experiments on the influence of the nature of surfaces upon the dissociation of chemical compounds.

The fifth and sixth parts of the *Journal* of the Society contain the following memoirs:—

Action of oxymethylen upon the amines, by M. Kolotoff.

Preparation of hexyl glycerol, by M. Orloff.

On the aromatic carbides contained in the petroleum of the Caucasus, by M. Dorochenko.

Session of September 12/24, 1885.—M. Tcheltzoff described researches on the formation-heats of calcium, strontium, barium, lead, magnesium, zinc, and copper picrates.

M. Konovaloff spoke of actions of contact in phenomena of dissociation.

M. Goloubeff described the composition of the liquid enclosed in Harden's "Fire Extinguisher." It contains scarcely anything but a mixture of sodium and ammonium chlorides.

M. Wilm sent in the results of analyses of platinum ores according to different methods. None of the methods in use give satisfactory results; the metals of the platinum group, as well as their salts, on precipitation from solu-

tions containing other metals, carry down with them a portion of the latter, which cannot be removed by washing. The same phenomenon is produced on the electrolysis of these solutions.

M. Werner communicated researches on the thermic data for some compounds of the aromatic series, and on the neutralisation-heat of mellitic acid.

M. Glinka has determined the crystalline form of calcium hydroxide.

M. Alexeef remarked, touching the endothermicity of carbon disulphide, that on referring the thermic effect of the formation of the sulphide to a red-heat, indispensable for the reaction, a positive effect is obtained.

M. Saytzeff gave a communication on the oxidation of oleic and elaidic acids by potassium permanganate.

MM. Albitzky and Nikolsky described the non-volatile product of the oxidation of the carbide $C_{12}H_{20}$.

M. Oustinoff gave an account of β-dimethyl-acrylic acid.

M. Barataeff described the action of allyl iodide and ethyl iodide upon ethyl oxalate, and gave an account of methoxyd allyl-acetic acid.

M. Dieff discussed the formation of acetic acid formed by the action of silver acetate upon diallyl-carbonyl tetrabromide.

MM. Tchebotareff and A. Saytzeff spoke of the action of ethyl iodide and zinc upon butyrone.

MM. Gortoloff and A. Saytzeff gave an account of the action of methyl iodide and zinc upon butyrone.

MM. Barataeff and Saytzeff spoke of the action of ethyl iodide and zinc upon diethylacetone.

MM. Oustinoff and Saytzeff described the action of propyl iodide and zinc upon butyrone.

M. Schrœder has determined the densities of aqueous and alcoholic solutions of mercuric chloride.

Bulletin de l'Association des Elèves de M. Fremy.
2nd Series, No. 5. January, 1886.

New Apparatus for the Electrolytic Determination of Copper.—A. H. Low.—A paper taken from the *Proceedings of the Colorado Scientific Society*. The apparatus is an ordinary galvano-plastic arrangement, in which a diaphragm of parchment paper is substituted for the porous earthenware cylinder.

Ixometer of L. Barbey.—This illustrated paper describes an instrument for measuring the viscosity of oils and other liquids. The purity of an oil can be determined by comparing its fluidity with that of a known type.

Areothermic Balance of Dr. F. Mohr for rapidly taking the Densities of Liquids and Solids.—This memoir requires the accompanying figure.

Electrolytic Separation of Zinc and Cadmium.—S. Eliasberg.—Already noticed under the *Zeitschrift fur Analytische Chemie.*

Use of Metallic Oxides for Detecting Coal-Tar Colours in Wines.—P. Cazeneuve.—From the *Comptes Rendus*, already noticed.

Alembic-Stove of M. Moitessier.—Figure and description of a gas-stove.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Cement.—If a quantity of waste old mortar were mixed with sandy clay (adding some barrels of fresh slaked lime), and spread evenly over a "si o floor," might it not be made available (for "cement") by watering with a solution of silicate of sodium? Any suggestions will oblige.—H. H.

MEETINGS FOR THE WEEK.

Monday, May 3rd.—Medical, 8.30.
—— Society of Chemical Industry, 8. "The Purification of Water," by A. G. Salamon, F.C.S. "The Treatment of Water for Technical Purposes," by Messrs. Macnab and Beckett.
—— Society of Arts, 8. (Cantor Lectures). "Animal Mechanics," by Dr. B. W. Richardson, F.R.S.
Tuesday, 4th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "Japanese Art Work," by Ernest Hart.
Wednesday, 5th.—Society of Arts, 8. Adjourned Discussion on Dr. C. Meymott Tidy's Paper on the "Treatment of Sewage."
Thursday, 6th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Alkaloids," by Prof. Dewar, F.R.S.
—— Society of Arts, 8. "The Commerce and Industries of New South Wales," by Edward Coombes.
—— Chemical, 8.
Friday, 7th.—Geologists' Association, 8.
—— Royal Institution, 9. "Dissociation," by Frederick Siemens.
—— Society of Arts, 8. "Indian Manufactures from a Practical Point of View," by B. H. Baden Powell.
Saturday, 8th.—Royal Institution, 3. "How to Form a Judgment on Musical Works," by Prof. Ernst Pauer.
—— Society of Arts, 3. "Electricity," by Professor George Forbes.
—— Physical, 3. "On a Modified Form of Wheatstone's Rheostat," by Shelford Bidwell.

TO CARBOLIC ACID AND DISINFECTANT MANUFACTURERS.

The Cartage Committee of the Hammersmith Vestry will be prepared, at its meeting to be held on Tuesday, May 11th, 1886, at 10 o'clock in the forenoon, to receive Tenders for the supply of CARBOLIC ACID at per gallon, and CARBOLIC DISINFECTING POWDER at per ton, and in 1 lb. packets at per gross.

The Acid to be supplied must contain about 90 per cent of Carbolic and Cresylic Acids, and the Powder to contain not less than 15 per cent of Carbolic Acid.

Any further information and forms of tender may be obtained upon application at the Vestry Hall, Broadway, Hammersmith, on and after Monday next, the 3rd of May, 1886.

Tenders, accompanied by samples of Acid and Powder, must be delivered here, not later than 9 30 a.m., on Tuesday, the 11th of May, marked "Tender for Disinfectants."

The Committee does not bind itself to accept the lowest or any tender.

(By order) W. P. COCKBURN, Vestry Clerk.

Vestry Hall, Broadway, Hammersmith,
29th April, 1886.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1380.

THE TREATMENT OF SEWAGE.

By F. MAXWELL LYTE, F.I.C., F.C.S.

Of all the methods of sewage precipitation the most effective seems to be that by aluminium hydroxide, and the cheapest and most advantageous mode of its formation is undoubtedly that by means of aluminium sulphate and sodium aluminate. The composition of this latter salt would appear to be not as yet fully determined. Roscoe gives $Na_2Al_2O_4=165$; Wurtz, $Na_6Al_4O_9=392$; and Groves $Na_6Al_2O_6=289$. It is possible that where sodium aluminate is formed by decomposing cryolyte with calcic hydrate, Groves's compound is formed; but otherwise the published analyses of aluminates hardly seem to me to justify the assumption that any aluminates exist of determined composition and of this constitution.

The percentages given for aluminates by Unverdorben, Vauquelin, and others, point to the correctnesss of the formula of Roscoe; but the instructions of Merijot and Debize, in their French translation of Knapp's "Chemical Technology," would rather imply that Wurtz's formula is the right one.

It seems to me probable that really chemically pure aluminates, in which the maximum of base is combined with the alumina, are of Roscoe's composition, but that for practical purposes, on account of the small quantity of silica and other impurities contained in the bauxite from which it is made, it is perhaps preferable to use the proportions indicated by the formula of Wurtz.

When sodium aluminate is mixed with aluminium sulphate the following reaction takes place, adopting, for reasons above mentioned, the formula of Wurtz:—

$$Na_6Al_4O_9+Al_2(SO_4)_3 18H_2O = \\ =3Na_2SO_4+3Al_2(HO)_6+9H_2O.$$

According to this, 6·68 grains of commercial aluminium sulphate containing 13·6 per cent of alumina, and 5·43 grains of crude sodium aluminate containing 27·3 per cent of soda and 33·5 of alumina, will produce as much aluminium hydroxide as 20 grains of aluminium sulphate of same composition with its quantum of lime; and in the former case only 3¼ grains of sodic sulphate (a perfectly innocuous salt) pass into solution, whereas in the latter there is dissolved about 10¼ grains of calcic sulphate per gallon, communicating to the effluent nearly 8 degrees of permanent hardness over and above that it originally possessed.

Suppose, for instance, 1,000,000 gallons of sewage, requiring for purification an addition of (say) 20 grains of commercial sulphate per gallon; this would take 20,000,000 grains = 1 ton 617 lbs., and about (say) 800 lbs. of lime, costing about £5, whereas the same end would be obtained with 954 lbs. of the same sulphate and 776 lbs. of crude aluminate, which, putting the first at £1 10s. and the second at £1 11s., makes in all but £3 1s. as against £5 for the old alum process; and further, in collecting the sludge formed by the old process, rather under ¼ of a ton of quicklime has to be added in order to get it to press, rendering it quite worthless as a manure; whereas with the aluminate process, the sludge, being in large part produced from alumina in alkaline combination, does not require the addition of lime. Experiments which have been made in view of valuing the dry sludge from the aluminate and sulphate process, have gone to show that it possesses a manurial value of 17s. 6d. a ton for nitrogen and phosphoric acid; but this is probably too low, as the sewage operated upon was of but poor quality, being swollen by rain till its volume was fully four times greater than usual.

Adopting it, however, for the moment, at the present price of soda ash, and that of French bauxite (17s. 6d. a ton f.o.b. Marseilles) for the latter, aluminate of soda may be made at good profit so easily that this treatment with aluminate and sulphate costs half, or nearly so, the price of the old process. In saying this allowance is made, on the one hand, for the value of the lime to be added to the sulphate, as well as that required for pressing the sludge in the old method, while, on the other hand, the value of the dried sludge from the aluminate and sulphate process is taken at 16s. a ton, in deduction of the cost by this method. Where, then, precipitation is to be employed, whether in conjunction with irrigation or not, the advantage of this process is evident.

Sewage treated in this way, with the quantities above stated, will be found to give an effluent of great purity, reducing to a minimum, if it does not in all cases obviate, the necessity for subsequent irrigation. Of course less quantities of aluminate and sulphate may be used, but the above are merely adopted as an example, being an equivalent of the 20 grains of sulphate lately used by the A B C Company in some demonstrations they were making with very good results; but whether the aluminium hydroxide formed be intended for use in this or any other process, the above method is by far the best way of forming it. Sodium aluminate is not at present produced on a large scale in England, but its manufacture is easy and advantageous, and doubtless it will not remain long without being made over here.

Besides the above action of the two salts aluminate and sulphate, conjoined in the formation of aluminium hydroxide for the treatment of sewage, there is also the use of aluminate, instead of carbonate of soda or caustic, which presents some advantages in the softening of permanently hard water for industrial purposes. Aluminate of soda, 27 or 28 per cent Na_2O, at £4 13s. per ton, being the equivalent, so far as the Na_2O is concerned, of caustic 60 per cent Na_2O, at £10 a ton; and while it acts just as effectively on the lime salts, producing permanent hardness, reacts far better on the salts of magnesium, to which part of the permanent hardness is often due, producing with them insoluble aluminate of magnesia, provided the carbonic acid be first of all rendered insoluble by an addition of lime-water. The difficulty of treating magnesian hardness is well known and recognised, and this takes place in virtue of the reaction shown by the formula—

$$Na_2Al_4O_9+3MgSO_4 = Mg_3Al_4O_9+3Na_2SO_4.$$

At the present price of soda-ash and bauxite aluminate of soda should be able to be produced for less than the above price, the manufacture of aluminate involving neither so long an operation or so much manipulation as caustic, and leaving no residue.

DO THE FLUORESCENCES OF $Z\alpha$ AND $Z\beta$ BELONG TO DIFFERENT EARTHS?

By M. LECOQ DE BOISBAUDRAN.

The author has expressed the opinion (*Comptes Rendus*, 1885, June, 1440, and September, 59) that the fluorescent bands near $\lambda=573$ and $\lambda=543$ characterise two special earths, which he has provisionally named $Z\alpha$ and $Z\beta$. His recent observations appear to agree with this view. The following are the facts:—

In the spectrum briefly described in *Comptes Rendus*, June, 1885, pp. 1437-38, the following bands belong to $Z\alpha$, or at least present features too analogous for it to be permissible to ascribe them to distinct elements:—

$$Z\alpha \begin{cases} 104\frac{9}{10} & .. \quad .. \quad \lambda=573 \\ 147\frac{1}{2} & .. \quad .. \quad \lambda=476\frac{1}{2}. \end{cases}$$

The other bands preserve among themselves relations of intensity as if belonging to one and the same body, $Z\beta$, the variations observed not being sufficiently decisive to indicate clearly the complexity of $Z\beta$.

$$|Z\beta \begin{cases} 91\frac{1}{2} & .. \; .. \; \lambda = 620\frac{1}{2} \\ 101 & .. \; .. \; \lambda = 585\frac{1}{2} \text{ double} \\ 115\frac{1}{2} & .. \; .. \; \lambda = 543\frac{1}{2} \\ 141\frac{1}{2} & .. \; .. \; \lambda = 487. \end{cases}$$

Relatively to the earth $Z\beta$, the earth $Z\alpha$ is at the first end of the fractionated precipitations by ammonia, and at the last end of the fractionations by potassium sulphate, or strong hydrochloric acid.

The addition of a very slight quantity of ruthenic, platinic, or ferric chlorides to solutions very rich in $Z\alpha$ and $Z\beta$, occasions the extinction or the weakening of all the bands of $Z\beta$, whilst $Z\alpha$ $104{,}^{9}_{0}$ is relatively little affected. We might here, therefore, advance one of the objections presented by Mr. Crookes, and say that $Z\alpha$ and $Z\beta$ are one and the same earth (Yt_2O_3 according to Mr. Crookes), whose different fluorescent bands undergo unequal alterations on the part of the foreign bodies present.

Nevertheless the experiment with ruthenium, platinum, and iron chlorides seems rather to speak in favour of the individuality of $Z\alpha$ and $Z\beta$. The author has indeed already pointed out the propinquity of the bands $Z\alpha$ $104{,}^{9}_{0}$ and $Z\beta$ 101; there is even a decided superposition of these bands. Thus the left margin of $Z\alpha$ $104{,}^{9}_{0}$ (observed in the absence of $Z\beta$ 101) reaches about $101{,}^{9}_{0}$ $\lambda = 584{\cdot}4$), and the right margin of $Z\beta$ 101 is placed nearly at $102{,}^{9}_{0}$ ($\lambda = 579{\cdot}3$). The intersection of the bands is therefore about $1\frac{1}{2}$ division of the micrometer, or $\lambda = 5{\cdot}1$.

It appears to me scarcely probable that the absorption of certain very refrangible rays, inducers of fluorescence, annihilates one of these bands to the exclusion of the other, if both belong to the same earth. Is it not more conceivable that if the rays exciting the fluorescences $Z\alpha$ and $Z\beta$ are of different refrangibilities, those which produce $Z\alpha$ may still act, whilst those corresponding to $Z\beta$ are intercepted?

The solutions of ruthenic, platinic, and ferric chloride absorb, in fact, all the radiations from the ultra-violet to a point which lies nearer the red the more concentrated is the liquid. This limit is not always very abrupt, but it is represented by a zone of rapidly decreasing absorption. But the solutions of the earths in which $Z\alpha$ predominates over $Z\beta$ extinguish the very refrangible rays only by absorption-bands, between which the light passes almost freely: these bands are especially those of holmium (?), erbium, and sometimes samarium and didymium. It was therefore interesting to know the effect of an addition of pure erbia or samaria to solutions giving fine $Z\beta$ spectra.

An earth containing a moderate but decided quantity of holmia, and a smaller proportion of erbia and didymia, was dissolved in hydrochloric acid in excess. By the reduced spark there was produced a fine spectrum of $Z\beta$ and a weaker one of $Z\alpha$. A considerable quantity of pure erbia was then introduced into the liquid, and it was found that the intensity of the fluorescences $Z\alpha$ and $Z\beta$ had not been very notably diminished.

The same experiment was then repeated, substituting for erbia pure oxide of didymium. Here the band $Z\beta$ 101 and a good part of the band $Z\alpha$ $104{,}^{9}_{0}$ were extinguished, by reason of the absorption of this part of the spectrum by didymium. The other bands $Z\beta$ remained very well marked, though rather more reduced than by erbia. The band $91\frac{1}{2}$ was relatively a little more attenuated than $115\frac{1}{2}$ and $141\frac{1}{2}$.

Lastly, the addition of a rather large quantity of pure samaria did not occasion any perceptible decrease in the brightness of the bands $Z\alpha$ and $Z\beta$. The experiment could not be made with holmia, as it has not yet been obtained in a state of purity.

According to these observations the presence of bodies giving discontinuous absorption-spectra along with the earths showing $Z\alpha$ more intense than $Z\beta$, does not seem sufficient to explain the relative feebleness of $Z\beta$ on the hypothesis that both these fluorescences are due to a single body.

Although the experiment could not be made with holmia it remains very probable that the absorption-bands of this earth, like those of erbiia, didymia, and samaria, would act but slightly upon the fluorescences $Z\alpha$ and $Z\beta$. The author, moreover, possesses a terbia containing slight traces of holmium and samarium, without erbium or didymium, the hydrochloric solution of which gives a splendid spectrum of $Z\beta$, with $Z\alpha$ still faintly visible, though incomparably weaker than $Z\beta$. If $Z\alpha$ and $Z\beta$ belong to one and the same earth, by what cause is the fluorescence $Z\alpha$ diminished to this point?

But if the exciting rays of $Z\alpha$ and $Z\beta$ are supposed identical, it may be that one of these fluorescences is produced to the almost complete exclusion of the other,—*e.g.*, in the case where the two fluorescences penetrate to different depths in the liquid. This interpretation is supported by the following experiment:—

If, at the surface of a solution rich in $Z\alpha$ and $Z\beta$ (containing no didymium, and not presenting an absorption-band near 105), we cause the reversed spark to strike about the middle of the liquid (at some millimetres from the side of the tube), we observe an increase in the lustre of the bands $Z\beta$, due doubtless to the fluorescent sheet being seen in section; but the band $Z\alpha$ $104{,}^{9}_{0}$ is extinct or much diminished. On bringing the spark near the side, against the liquid meniscus, $Z\alpha$ is restored to its full strength. This effect seems due to the fluorescence; $Z\alpha$ is produced at a very slight depth in the liquid, whose surface, being distorted by the contact of the electric jet, prevents the light from arriving at the slit of the spectroscope. When by means of the play of a mirror we throw upon the slit not the light emitted horizontally, but that which follows a strongly descending direction, the spectrum of $Z\alpha$ reappears.

The slight depth of the fluorescence $Z\alpha$ may lastly contribute to explain how this fluorescence is moderately influenced by ruthenium, platinum, and iron chlorides, the quantity of these bodies traversed by the exciting rays being very small.

The products which give the most brilliant $Z\alpha$ and $Z\beta$ are those which contain the least yttria or which contain none at all. The author is therefore convinced that the fluorescent spectrum at first attributed to yttria is not due to this earth, and is composed solely of the bands of $Z\alpha$, $Z\beta$, and samarium. He adds that his learned friend Mr. Crookes continues not to accept this opinion.

It results, therefore, from the author's researches that neither holmia nor $Z\alpha$ can be the cause of the orange colouration of the terbias. He does not venture to allege that the earths Ho and $Z\alpha$ are absolutely colourless, not having obtained them pure, but they concentrate themselves in very pale oxides obtained from the fractionation of the terbias, so that their colouration must be very slight.—*Comptes Rendus*, vol. cii., p. 899.

ON THE VANADATES AND IODYRITE FROM LAKE VALLEY, SIERRA CO., NEW MEXICO.*

By F. A. GENTH and GERHARD VOM RATH.

At a meeting of the American Institute of Mining Engineers, held at Washington, D.C., in 1882, the late Prof. Benj. Silliman read a paper "On the Mineral Regions of Southern New Mexico,"† in which he gave the first fuller information about the extraordinary occurrence

* Read before the American Philosophical Society, April 17th, 1885.

† *Engineering and Mining Journal*, New York, October 14 and 21, 1882, pp. 199 and 206; 212, 213, and 214.

of rich silver ores and the accompanying minerals in the mines of the so-called Sierra Group, comprising the Sierra Grande, Sierra Bella, and Sierra Apache.

The geological position had been determined in 1881 by Prof. E. D. Cope, when he showed that the strata in which the ores occur belong to the lower coal-measures.

The ores form a bed more or less interrupted, or rather a series of huge lenticular beds or pockets between the limestone strata, which show a dip of about 30° towards the S.E. This dip flattens to one only of about 15° at a depth of 180 feet. The ore bed is frequently divided by intercalations of limestone strata.

The foot wall consists of a hard, more or less siliceous, blue limestone, with very few fossils, into which the ores frequently penetrate, as if by alteration of the bed rock. The hanging wall is formed by a pale slaty limestone without siliceous inclosures, rich in fossils, but without any ores. The separation between the hanging wall and the ore bed is perfect.

The main body of the ores is formed by oxides of iron and manganese; hæmatite, limonite, pyrolusite, manganite, psilomelane, and wad, intermixed with variable quantities of cerargyrite and embolite, together with small quantities of native silver and highly argentiferous cerussite and galenite. At many places the upper portion of the ore bed consists of flint and siliceous minerals which cover the argentiferous iron ores, and which are sometimes rich in embolite; pale yellow crystals of vanadinite in druses of quartz are sometimes met with.

These facts, mostly taken from Prof. Silliman's paper, give a brief account of the geological position and the accompanying minerals which he had observed.

A few months ago a highly interesting find was made at the Sierra Grande, which furnished some beautiful specimens of very rare species, of which we received a sufficient supply for investigation from Mr. N. H. Muhlenberg, in Lake Valley, and his representative in Reading, Pa., Mr. Theodore A. Kendall, to whom we are greatly indebted for their liberality; also to Mr. Robt. C. Canby, at Pueblo, Coll., who has kindly furnished the writer with the vanadinite from the Sierra Bella.

In the following investigation the crystallographic measurements and figures are by Gerhard vom Rath, and the analyses, &c., by F. A. Genth.

It may be well to give a general outline of the methods employed for the analyses of the vanadates described in this paper.

After dissolving in very dilute nitric acid, the insoluble residue was filtered off, then treated again two or three times with dilute nitric acid in order to bring all the vanadates into solution. This was especially necessary in the case of the dark descloizites; but, notwithstanding this, some of the constituents of this mineral remained undissolved, and appreciable quantities of lead, copper, and zinc were retained, probably by the manganese dioxide, which was present in considerable quantities. These bases were determined, and their quantity added to the main portion.

In the filtrate the chlorine was precipitated by a few drops of silver nitrate, the excess of silver removed by just enough hydrogen chloride, and the filtrate from the silver chloride evaporated nearly to dryness. A large excess of strong hydrogen sulphide water was then added, and the beaker put at a warm place for two days. Lead, copper, and arsenic were precipitated as sulphides, but also, invariably, more or less zinc,* although the solution was still strongly acid. After two days' standing, the solution had yet a strong odour of hydrogen sulphide. It was filtered off, and the arsenious sulphide separated from the sulphides of lead, copper, and zinc, by digestion with sodium hydrate, the filtrate precipitated with hydrogen chloride; the arsenious sulphide, thus obtained, oxidised with strong nitric acid into arsenic acid, which was weighed as pyro-arseniate of magnesium. The precipitate, containing lead, copper, and part of the zinc as sulphides, was oxidised with strong nitric acid; sulphuric acid was then added, and evaporated until the nitric acid was completely expelled. In the filtrate from the lead sulphate the copper was precipitated as sulphide and weighed as oxide, and the zinc converted into sulphide, after neutralisation with ammonia, and added to the main portion.

The filtrate from the first hydrogen sulphide precipitate was evaporated and the tetraoxide of vanadium reconverted into vanadic acid by the nitric acid present, whereupon the solution was boiled with sodium carbonate to separate the zinc, manganese, and iron from the *greater* part of the vanadic and phosphoric acids. As this separation is not complete, the precipitate was fused with sodium carbonate and lixiviated with water, after having reduced the manganic acid by a few drops of alcohol. Iron was separated from zinc and manganese by sodium acetate, the zinc precipitated by hydrogen sulphide from the cold filtrate, after acidulating strongly with acetic acid, and finally the manganese by sodium carbonate. In the united solutions, containing vanadic and phosphoric acids, the sodium carbonate was nearly neutralised with acetic acid, and the two acids precipitated either by mercurous nitrate or lead acetate. In the first case the mercury was driven off at the lowest possible temperature, then a little nitric acid was added, the liquid evaporated to dryness, after which the residue, containing pentoxide of vanadium and metaphosphoric acid, was ignited; in the second place, the lead salt was mixed with a little nitric acid, the lead removed as sulphide, the filtrate evaporated, and the residue ignited.

It now remained to separate the phosphoric acid from the vanadic pentoxide. They were dissolved in boiling hydrogen chloride, completely reduced by sulphurous acid, and, after having added a little tartaric acid and a large excess of ammonia, precipitated with magnesia solution. On account of the minute quantity of phosphoric acid, the liquid was allowed to stand a long time in order to secure a complete precipitation, but, in doing this, a small quantity of the reduced vanadic acid was re-oxidised and contaminated the phosphate with a minute quantity of magnesium-ammonium vanadate. It was necessary, therefore, to re-dissolve in hydrogen chloride, and after addition of a little sulphurous and tartaric acids to re-precipitate by ammonia, when a perfectly white pyrophosphate of magnesium was obtained.

Vanadinite.

Prof. Silliman was the first to observe vanadinite in pale yellow hexagonal crystals at the Lake Valley Mines.

a. At the Sierra Bella it is found on wad in thin coatings, consisting of minute crystals of a brownish yellow colour, which, under the microscope, show bright hexagonal prisms with the basal plane and the pyramid slightly indicated; powder yellow. Analysis *a*.

b. At the Sierra Grande several varieties are found.

1. Beautiful crystals, the largest not over 5 m.m. long and 2·5 to 3 m.m. thick; hexagonal prisms, terminated by the basal plane and the pyramid. The angle between the prism and pyramid was found by measurement to be nearly 130°. The planes are often rough, as if corroded by a solvent, and the crystals frequently show cavities; some appear as skeleton-like residues. Smaller crystals of about 1·5 to 2 m.m. in length are perfectly developed, and show smooth brilliant faces. The colour is orange-yellow, varying from wax-yellow on one side to a deep orange-red, the terminations being generally of the darkest colour; cloudy. Powder pale orange-yellow. Lustre greasy, inclining to vitreous. Associated with pyrolusite and implanted in calcite. Minute very brilliant columbine-red or cherry-red crystals of descloisite are implanted in or crystallised upon the vanadinite and calcite, and may have been formed from constituents of decomposed or dissolved vanadinite. Analysis *b* 1.

* In the analysis of descloisite, *a* 2, the zinc was lost, because the filtrate from the lead sulphate, which contained a portion of it, was accidentally thrown away.

2. Other varieties of vanadinite are associated with the black or dark brown descloizite. They all show the hexagonal prism and the basal plane, and most of the crystals the pyramid also; a more acute pyramid, and a prism and pyramid of the second order are rarely indicated. The planes are generally smooth and brilliant, but there are some, in which the basal plane is rough, as if corroded, but surrounded by a smooth and brilliant margin. The crystals vary in size from 1·5 to 3 m.m. in length, and 0·5 to 2 m.m. in thickness. Their colour is from orange-yellow to brownish orange.

They are mostly of a more recent origin than the brown descloizite which they accompany; it appears, however, that the latter was still growing when this vanadinite and iodyrite were formed, since the large crystals of descloizite are frequently pitted by their impressions; the vanadinite and iodyrite seem to have crystallised simultaneously, but there are smaller crystals of descloizite, of a red colour, of a more recent origin: they are attached to iodyrite, vanadinite, and calcite.

Analyses:—

a. As not enough of the pure mineral from the Sierra Bella could be obtained, an indefinite quantity of the incrustations upon wad was purified as much as possible by washing off the lighter particles, and analysed. It gave—0·0153 grm. Ag = 0·0050 grm. Cl, 0·2261 grm. $PbSO_4$, 0·0007 grm. $Mg_2As_2O_7$, 0·0021 grm. $Mg_2P_2O_7$, and 0·0364 grm. V_2O_5.

b 1. One grm. gave—0·0757 grm. Ag = 0·0249 grm. Cl, 1·0647 grm. $PbSO_4$, and 0·1814 grm. $(VP)_2O_5$. 1·5665 grm., after deducting 0·0008 grm. quartz, or 1·5657 grm. pure vanadinite, gave—1·6669 grm. $PbSO_4$, 0·0282 grm. $Mg_2As_2O_7$, 0·0095 grm. $Mg_2P_2O_7$, and 0·2779 grm. V_2O_5. These quantities give the following percentage:—

	a. Sierra Bella.		*b*1. Sierra Grande.	
Sp. gr. =	—	Atomic ratio.	6·862	Atomic ratio.
Cl	2·39—0·067	= 1	2·49—[2·49]—0·070	= 1
P_2O_5	0·57—0·004		— 0·39—0·003	
V_2O_5	17·37—0·095	= 0·100 = 1·49	18·14 —17·74—0·097	= 0·106 = 1·5
As_2O_5	0·24—0·001		Not det. — 1·33—0·006	
PbO	79·43—0·356	= 5·31	78·36—78·31—0·351	= 5
ZnO	—		trace	
			Less O	100·26
			Equiv. to Cl	0·55
				99·71

b 1. One grm. gave—[illegible] grm. Ag = 0·0249 grm. Cl, 1·0647 grm. $PbSO_4$, and 0·1814 grm. $(VP)_2O_5$. 1·5665 grm., after deducting 0·0008 grm. quartz, or 1·5657 grm. pure vanadinite, gave—1·6669 grm. $PbSO_4$, 0·0282 grm. $Mg_2As_2O_7$, 0·0095 grm. $Mg_2P_2O_7$, and 0·2779 grm. V_2O_5. These quantities give the following percentage:—

The analysis *b* 1 corresponds exactly to the formula $Pb_5Cl[(VAsP)O_4]_3$, in which a small portion of the vanadium is replaced by arsenic and phosphorus, while analysis shows a slight excess of lead, which is probably present as cerussite.

Endlichite, or Vanadium-Mimetite, a New Species.

In the collection of Mr. Clarence S. Bement was a specimen, labelled Vanadinite, which showed such a peculiar appearance that its examination was desirable, for which purpose he has kindly loaned the same.

There are apparently three kinds of crystals present; some of an orange-yellow and orange-red colour, probably vanadinite; the largest a little over 1 m.m. in size: they are hexagonal prisms with pyramid, and, slightly developed, a second more acute pyramid; both the prismatic and the pyramidal planes are strongly striated through oscillation of the pyramidal planes with the prismatic; then there are one or two bright yellow, very minute crystals, which are imperfect, and appear as if made up of several individuals: the planes are the same as those of the orange crystals. The third mineral is developed in the form of very bright straw-yellow crystals, showing the strong striation of the prismatic planes and the two pyramids. On the largest crystals, not over 1 m.m. in length, the basal plane is visible; on the small ones it is quite obliterated. A few of the crystals were hollow.

An imperfect qualitative analysis gave no satisfactory results, on account of the exceedingly minute quantity at disposal. Fortunately Mr. Muhlenberg succeeded in securing for examination another small specimen which showed some peculiarities, but was evidently the same as Mr. Bement's specimen. Implanted in drusy quartz coloured by ferric and manganic oxides, the crystals are yellowish white or pale straw-yellow, the largest 3 m.m. long and from 0·5 to 1·5 m.m. thick; the forms are those given above. Some of the crystals show only a hollow prism, either empty or filled with a crystalline powder which now and then assumes hexagonal forms. As the specimen contained only a very minute quantity which could not be picked out, an analysis was made from all the fragments of quartz which showed some of this mineral. On dissolving in dilute nitric acid a slight evolution of carbonic dioxide was observed.

0·9518 grm. gave—0·7276 grm. insoluble quartz, &c., 0·0094 grm. Fe_2O_3, 0·0029 grm. CaO, 0·0127 grm. Ag = 0·00417 grm. Cl, 0·0277 grm. $Mg_2As_2O_7$, 0·0152 grm. V_2O_5, and an unweighable trace of $Mg_2P_2O_7$. This gives—

Quartz, &c.	76·44 per cent.
Fe_2O_3	0·99
CaO	0·30
Cl	0·44
As_2O_5	2·16
P_2O_5	trace
V_2O_5	1·60
PbO	15·94
CO_2, H_2O, &c.	2·13 by difference.
	100·00

Deducting the admixtures the pure mineral contains—

		Atomic ratio.
Cl	2·18 = 0·061	= 1
As_2O_5	10·73 = 0·047	= 0·090 = 1·48
V_2O_5	7·94 = 0·043	
PbO	79·15 = 0·355	= 5·82
	100·00	

The small excess of lead is evidently owing to an admixture of cerussite, and the mineral is a combination of 1 molecule of mimetite with 1 molecule of vanadinite =

$$= Pb_5Cl[AsO_4]_3 + Pb_5Cl[VO_4]_3,$$

corresponding to which is the following:—

Cl	2·44
Pb	7·11
As_2O_5	11·86
V_2O_5	9·60
PbO	68·99
	100·00

The name has been suggested by Mr. N. H. Muhlenberg in honour of Dr. F. M. Endlich, Superintendent of the Sierra Mines at Lake Valley, N.M.

Since the above has been written Mr. Muhlenberg sent a new supply of endlichite which was different in appearance from that previously seen. It consisted of groups of crystals of a columnar structure, some radiating from a centre, and also forming sheaf-like aggregations. In many of them the hexagonal form could be distinctly seen, especially towards the diverging ends, which show the basal plane and pyramid very distinctly. They are all strongly striated. The individual crystals are white and yellowish white or straw-yellow, towards their terminations often changing to yellow, and in a few groups to a deep orange-red. The largest groups were 10 m.m. in length.

The whitest gave a sp. gr. of 6·864, and contained—

		Atomic ratio.	
Cl	2·45	= 0·069	
PbO	73·48	= 0·330	= 0·336
CaO	0·34	= 0·006	
As_2O_5	13·52	= 0·087	
V_2O_5	10·98	= 0·084	
P_2O_5	trace		
	100·77		

From this the ratio of the constituents appears to be about the same as found before, and that arsenic and vanadium are present in the proportion of 1 : 1.

The change of colour of these groups of crystals, however, appears to indicate that the vanadiferous mimetite or endlichite may gradually change into vanadinite.

Probably the same mineral has already been observed by Prof. Silliman at the Torrence Mine, Socorro, N.M., where it occurs in small yellow hexagonal prisms which were mistaken for vanadinite, but were mimetite containing vanadium.

ON THE DETERMINATION OF ARSENIC.*

By LeROY W. McCAY.

Arsenic and its compounds have until lately proved very unsatisfactory things for the chemist to determine. There are indeed few common elements the quantitative estimation of which has, up to within the last few years, presented such numerous, persistent, and extraordinary difficulties as the one forming the subject of this paper. As a matter of fact there is, at the present day, no gravimetric method for estimating arsenic which is not without fault. The one most commonly used, that of Levol, is open to at least two serious objections. In the first place the ammonium magnesium arseniate is perceptibly soluble in ammonia water, and in the second place the danger of occasioning a loss of arsenic by the reducing action of the ammonia upon igniting the salt is a fact too well known to need mention. Chemists, it will be remembered, have endeavoured to avoid the error arising in the first instance by the addition of alcohol to the solution to be precipitated, but even in ammoniacal alcohol the double arseniate is sensibly soluble; consequently, although considerably reduced, the error cannot be said to be entirely eliminated. Attempts have also been made, and that too with a considerable amount of success, to avoid the error arising in the second instance by removing the salt particles adhering to the filter-paper with dilute nitric acid, moistening the precipitate with the same reagent, and igniting—at first gently, then strongly. Much skill and care, however, is requisite in the process of igniting, it being no uncommon occurrence, when the heat is too suddenly applied, to drive off a portion of the ammonia at such a rate as to occasion considerable reduction, even in such a strong oxidising atmosphere as nitrous oxide.†

Not long since Bunsen* published an article upon the separation of arsenic and antimony, and upon the determination of each as sulphide. The separation of the two elements is quick, easy, and accurate. As regards the estimation of the arsenic, however, it is, as Fresenius has already intimated, undoubtedly necessary, in order to ensure correct results, to follow Bunsen's details to the letter; for although the sulphide obtained by precipitating the arsenic from a solution thoroughly treated with chlorine has, after having undergone a detailed course of washing, exactly the composition of arsenic pentasulphide, and is in fact regarded by Bunsen as being such, it must not be forgotten that no less an authority than Rose† declares the precipitate occasioned by sulphuretted hydrogen in solutions of arsenic acid to be not pure arsenic pentasulphide, As_2S_5, but a mixture of the trisulphide, As_2S_3, and sulphur. If Rose's statement is true, then the chances are that a slight departure from the directions as given by Bunsen might occasion incorrect results in the determination of the element. Besides the objection to be found in the uncertainty as to the actual character of the sulphide obtained by neglecting to follow Bunsen's details absolutely, another and serious one can be urged against the necessity of being compelled to weigh the precipitate on a tared filter-paper after having thoroughly dried at 110° C. I willingly grant that the Bunsen method furnishes perfectly correct results, and that it is a wonderful improvement upon the old method of Levol; still it is a long, tedious, and unpleasant operation. The arsenic is precipitated very slowly from the solution of arsenic acid, and unless the precipitate is filtered off at just the right point some arsenic is sure to remain in solution. The precipitation, in fact, requires much attention, patience, and practice, and in consequence thereof it is with much pleasure and satisfaction that we welcome the beautiful proposal of Carl Holthof.‡

Mohr's method for estimating arsenic is one of the most simple and exact in the field of analytical chemistry. It presupposes, however, the existence of the arsenic in the state of arsenious acid, a condition which is rarely fulfilled, inasmuch as in the regular course of analysis arsenic is almost invariably obtained as arsenic trisulphide or arsenic acid. The method, it will be remembered, depends upon the fact that in a weakly alkaline solution arsenic in the state of arsenious acid is oxidised by iodine to arsenic acid, in accordance with the equation—

$$H_3AsO_3 + 2I + H_2O = H_3AsO_4 + 2HI.$$

The difficulty of obtaining the arsenic in the minimum state of oxidation has caused the method of Mohr to fall into neglect, and consequently escape that attention which is due to it.

Many years ago Holthof obtained very satisfactory results by carefully oxidising small quantities of sulphide of arsenic with nitric acid in a porcelain dish, evaporating to dryness with a few drops of sulphuric acid, and boiling down in a large beaker to one-third the original volume, after having first added one-third of a litre of sulphurous acid solution, then re-filling to the mark with sulphurous acid solution, and again evaporating to one-third the original volume, neutralising, after cooling, with sodium carbonate, adding a constant quantity of mono-sodium carbonate, a little starch solution, and titrating with a standard solution of iodine. Holthof evidently did not at that time publish anything relating to this method of determining arsenic, for in speaking of it in the first part of his recent paper he makes no reference to any work or

* *American Chemical Journal*, vol. vii., No. 6.

† Bemmer, who proposes the igniting of the precipitate in an atmosphere of nitrous oxide, directs that the salt be brought into a small thin porcelain crucible; that this crucible be placed in a larger one of platinum, and that the heat be then applied, very gently at first, then gradually stronger, until the full capacity of the burner is reached.

* *Zeitschr. f. Anal. Chem.*, xvi., 57. See also Reichel, *Zeitschr. f. Anal. Chem.*, xx., 89.

† Rose, *Pogg. Ann.*, cvii., 186. Wackenroder arrived at the same results prior to Rose. See Ludwig's investigations, *Ar. d. Pharm.*, 2 Reihe, xcvii., 32. Also A. Fuchs, *Zeitschr. f. Anal. Chem.*, lxxxi., 189.

‡ Holthof, *Zeitschr. f. Anal. Chem.*, xxiii., 378.

periodical. A little over a year ago, at the instigation and in the laboratory of Fresenius in Wiesbaden, he undertook a thorough study of the process, it being his chief object to discover whether the mode of procedure was applicable in the case of large quantities of arsenic, and also practicable in determining the arsenic in the strong hydrochloric acid solution which is obtained when working according to the Bunsen separation method. It will be at once evident that the success of the method depends upon the complete reduction of the arsenic from the arsenic to the arsenious state of oxidation. Holthof starts out with the assumption* that when a sufficient quantity of sulphurous acid is used, and the solution is heated for a sufficient length of time, the reduction is complete, and in the end he proves that this is the case.

In brief Holthof's method is as follows:—1. The solution, containing about 0·10 to 0·20 grm. arsenious oxide, As_2O_3, as arsenic oxide, As_2O_5, is brought to 50 c.c. and diluted in a flask with 100 to 150 c.c. sulphurous acid and 150 to 200 c.c. water. The flask with its contents is then heated for four hours, and next boiled down over a free flame to one-half the original volume. A little clear starch solution is now run in, 40 c.c. of a solution of hydrosodium carbonate saturated in the cold added, the whole diluted to about one-third of a litre, and titrated to a light sky-blue, with a standard solution of iodine containing approximately 10·0 grms. iodine to the litre. The test analyses, although not numerous, are very satisfactory.

2. Holthof did not experiment upon sulphide of arsenic, at all events not in the case before us; but his thorough study of the oxidising action of chlorine upon the arsenious acid, and his examination of the question relating to the volatility of arsenic trichloride when a solution of arsenic acid is evaporated to dryness with excess of hydrochloric acid, justify us in presuming that, according to him, the following would be the method of procedure in the case of sulphide of arsenic† :—The sulphide of arsenic is brought into a little porcelain dish provided with a watch-glass cover, and treated either with fuming nitric acid or potassium chlorate and hydrochloric acid until solution is complete. The liquid is then evaporated, a few drops of sulphuric acid added, diluted, reduced as already described, boiled down to one-half the original volume, cooled, evaporated to about 300 c.c., and titrated to a light blue. The test analyses resulting from evaporating arsenic pentoxide, As_2O_5, solutions in the presence of excess of chlorine and hydrochloric acid are good, and prove conclusively that when arsenic acid, chlorine, and hydrochloric acid are evaporated upon the water-bath no arsenic is volatilised as trichloride. The two sets of experiments then prove:—

1st. That the reduction with sulphurous acid is complete. 2nd. That upon evaporating arsenic pentoxide, As_2O_5, in the presence of hydrochloric acid, no arsenic escapes as trichloride.

Holthof concludes from the above that not only is the method suitable for technical needs, but also that its exactness renders it worthy of being used for scientific purposes.

For some time past I have been engaged in making a thorough examination of the method of Holthof, and I have reached the conclusion that it is the most perfect one at present known. Further, by taking advantage of a device of my own, the time requisite for making a determination is reduced to a minimum. At the outset I went over Holthof's work for the purpose of determining whether the reduction, when made in strict accordance with his directions, is so complete as to render it impossible to detect, by qualitative measure, any arsenic acid in the liquid after boiling down to one-half the original volume and then carefully evaporating to about 50 c.c.

In order to obtain a solution suitable for qualitative as well as quantitative experiments, I dissolved 28·90 grms. H_2KAsO_4 in about 250 c.c. water, and diluted to 2 litres. Theoretically every 10 c.c. of this solution should contain 0·0602 grm. As = 0·0794 grm. As_2O_3 = 0·0923 grm. As_2O_5. However, being ignorant as to the exact degree of purity of the salt, the solution was carefully analysed—1st, by the method of Levol; 2nd, by the method of Reich.

1st. Ten c.c. were put into a small beaker, rendered strongly acid with hydrochloric acid, then strongly alkaline with ammonia, cooled, and finally precipitated with magnesia mixture, care being taken to add this reagent slowly, drop by drop, and with constant stirring. After standing twelve hours the ammonium magnesium arseniate was filtered off, washed with ammoniacal water, dried, moistened with nitric acid, and ignited, all details relating to the extraction of the particles of the salt from the filter-paper with dilute nitric acid being strictly observed. The 10 c.c. gave 0·1215 grm. $Mg_2As_2O_7$ = 0·0591 grm. As = 0·0780 grm. As_2O_3 = 0·0906 grm. As_2O_5. These figures, it will be observed, are somewhat lower than those required by theory.

2nd. *Three Estimations.*—*a*. One volumetrically; *b*. Two gravimetrically.

a. Ten c.c. were put into a small beaker, about 50 c.c. water added, and enough ammonia to produce a decided alkaline reaction dropped in. The solution was then heated to boiling, and a quantity of silver nitrate sufficient to ensure complete precipitation of the arsenic run in. The liquid was now stirred briskly until the precipitate exhibited a tendency to settle, leaving the supernatant fluid clear. The beaker with its contents was next removed from the flame, and ammonia water added to faint but distinct alkaline reaction. This alkaline reaction was removed by the aid of a drop of acetic acid, the liquid again thoroughly stirred, the whole allowed to stand for a few minutes, and, after entire subsidence, the silver arseniate filtered off, washed with pure cold water, dissolved off the filter-paper with a little dilute nitric acid, and the combined silver determined according to Volhard.* I found 0·2572 grm. Ag = 0·0595 grm. As = 0·0785 grm. As_2O_3 = 0·0912 grm. As_2O_5. The method of neutralising the solution is my own.

b. For the two estimations made gravimetrically, and according to my own modification† of the Reich process, I used in each case 10 c.c. The precipitation of the arsenic was made exactly as above described, but instead of dissolving the silver arseniate in nitric acid and titrating the silver, the precipitate was removed from the filter-paper by means of a few drops of ammonia and a little water, the solution caught in a small weighed platinum dish, evaporated to dryness, the residue heated for a short time at 100° C., and then weighed. From the formula Ag_3AsO_4 the arsenic was calculated. I found (1) 0·3661 grm. Ag_3AsO_4 = 0·0592 grm. As = 0·0781 grm. As_2O_3 = 0·0907 grm. As_2O_5; (2) 0·3659 grm. Ag_3AsO_4 = 0·0592 grm. As = 0·0781 grm. As_2O_3 = 0·0907 grm. As_2O_5. Since the molecular weight of Ag_3AsO_4 = 463, and the atomic weight of As = 75, the relation between the two is about 6 : 1, or a difference of 6 m.grms. in the weight of the silver salt will occasion a difference of but 1 m.grm. in the weight of the arsenic. The wonderful degree of accuracy of the method is at once evident. The Levol method gave 0·0591 grm. metallic arsenic; the Reich method 0·0593 grm. of the element in 10 c.c. The difference, 0·0002 grm., is due probably to the solubility of the ammonium magnesium arseniate in ammoniacal water. The figure 0·0593 is undoubtedly the correct one, and we shall in our future work regard it as such.

(To be continued).

* See the communication of Wöhler, *Ann. d. Chem. und Pharm.*, xxx, 224.

† See his method of procedure as practised in former years.

* Pearce's modification of the Reich method. For particulars see *Engineering and Mining Journal*, xxxv., 256. See also CHEMICAL NEWS, xlviii., 85.

† For another modification see CHEMICAL NEWS, xlviii., 7 and 268.

LOSS OF AMMONIA ON MIXING SULPHATE OF AMMONIA WITH CALCAREOUS SOIL.

By W. BAXTER.

The loss of ammonia referred to by Mr. Brown in his communication (Chemical News, vol. liii., p. 182) came under my notice a short time ago under circumstances somewhat similar to those which he describes, the substance with which the sulphate of ammonia was mixed in this case being, however, what is known as Navasa guano. My attention was called to the alteration in smell which occurred on this material being mixed with sulphate of ammonia. The suggestion that the alteration resulted from the decomposition of the sulphate of ammonia was soon demonstrated by a few experiments of similar character to those mentioned by Mr. Brown. It was thought that the decomposition might arise from the presence of caustic lime in the guano, and a considerable quantity of lime was found in an aqueous solution of material, but as it was accompanied by sulphuric acid no conclusion to this effect could be drawn from the experiments made, as the lime might all exist as calcium sulphate. The practical conclusion arrived at, however, was that a loss of ammonia must be experienced in mixing sulphate of ammonia with such a fertilising agent.

I may add that the aqueous solution quickly turns reddened litmus-paper blue. It might be of interest to know if an aqueous solution of the soil Mr. Brown experimented with would produce the same effect.

Possibly the presence of a small quantity of an alkaline carbonate may account for the decomposition.

Edinburgh, April 20, 1886.

A NEW METHOD FOR THE DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.*

By J. B. MACKINTOSH, School of Mines, New York.

The general method which has been followed since the time of Heinrich Rose, and perhaps before, for the determination of phosphorus in iron and steel, is to dissolve the sample either in nitric acid, *aqua regia*, or some other oxidising agent, in order to convert the phosphorus into phosphoric acid.

In 1832 Rose† recommends HNO_3, or *aqua regia*, preferably the former. Wöhler, in 1854,‡ directs that the iron should be oxidised by burning in a stream of oxygen for the determination of carbon, and the resulting oxide of iron containing all the phosphorus as phosphoric acid be treated as an ore. In the fourth English edition of Fresenius's "Quantitative Analysis,"§ pp. 666 to 667, we find directions to dissolve the iron in *aqua regia* or bromine; and, coming down to more recent times, we find F. A. Cairns‖ directing the employment of a boiling solution of potassium chlorate and hydrochloric acid for the oxidation and solution of the sample to be analysed. It is unnecessary to multiply quotations from the literature of the subject, though they might be extended almost indefinitely, since it would only be a repetition of the above-mentioned series of methods in one form or another; and the references given have been selected to show how little essential variation there is in the type-methods of solution used. In fact it seems to be universally accepted as a necessary first step in the determination that some such method of solution should be followed.

One chemist, however, struck out on a different line of thought, and to the best of my knowledge only one, M. V. Tantin, who, in a contribution to the *Comptes Rendus* (I have not been able to find the original article, however), copied in the Chemical News,* describes his method for determining phosphorus in cast-iron as follows:—

"When seeking the means of avoiding these sources of error,† I concluded that the best way of so doing would be to use a precisely contrary method, namely, by liberating the phosphorus as a hydrogen compound; but one objection naturally arose—would the totality of the phosphorus pass into the state of a gaseous product? I may safely affirm that I have never been able to discover the least trace of phosphorus in the residue after the complete attack of the cast-iron by chlorhydric acid, which fact is not surprising if it be considered what strong affinities phosphorus has for hydrogen."

According to M. Tantin the resulting gases, composed of phosphuretted, arsenuretted, sulphuretted, and carburetted hydrogen, are passed through potash and then into nitrate of silver, where all the phosphuretted hydrogen is caught as phosphide of silver, which is afterwards treated with *aqua regia*, and the phosphoric acid resulting determined as ammonic-magnesic phosphate. The following precautions are mentioned as indispensable.

1. The cast-iron must be attacked very slowly, or part of the phosphuretted hydrogen may traverse the solution of nitrate of silver without being absorbed.

2. When the solution is finished a current of hydrogen is to be passed through the apparatus.

M. Tantin seems to have overlooked the possibility of some of the phosphorus remaining in the solution, and to have assumed that if none was found in the residue all must have gone off with the gas. If such were the case, the determination of phosphorus would be much simplified.

Some years ago I tried this method on a pig-iron which I knew ran over one per cent of phosphorus, but my final precipitate, if any, of ammonic-magnesic phosphate was so small as to be invisible. I concluded that the method was not suited for American pig-irons, and gave no more attention to the subject till the summer of last year, during which I had considerable leisure time for experiment.

In Watts's "Dictionary of Chemistry"‡ we find the statement, "When a very small quantity of phosphorus is associated with a large quantity of iron, as in many kinds of pig-iron, the whole dissolves in hydrochloric or dilute sulphuric acid, the phosphorus passing into solution as phosphoric acid." This statement is the very reverse of that made by M. Tantin, and to ascertain its accuracy I made the following experiment.

I had just finished an analysis of bar-iron which, by the ordinary method I used,§ had given 0·124 per cent phosphorus. I took 10 grms. of this and dissolved it in hydrochloric acid, finally boiling the solution, neutralised with ammonia, and, after adding a few c.c. of permanganate to oxidise a little iron, precipitated basic acetates, boiling the filtrate twice for further precipitates; the combined precipitates were dissolved in hydrochloric acid, oxidised with nitric, precipitated with ammonia, and the precipitate re-dissolved in nitric acid, and the phosphorus pre-

* From the *Transactions of the American Institute of Mining Engineers*.

† Rose's "Traité Pratique d'Analyse Chimique." Translated from the second German edition, by A. J. L. Jourdan, 1832, vol. ii., p. 414.

‡ Wöhler's "Handbook of Inorganic Analysis." Edited by A. W. Hofmann. London, 1854, p. 61.

§ 1865.

‖ "A Manual of Quantitative Chemical Analysis." By F. A. Cairns, A.M., 1880, p. 114.

* Chemical News, xviii., p. 252.

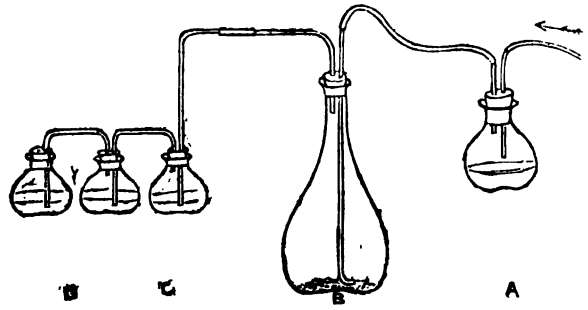
† Loss as phosphuretted hydrogen; estimation of arsenic as phosphorus; and errors due to a large bulk of solutions employed.

‡ 1886, vol. iv., p. 519.

§ Ten grms. dissolved in 120 c.c. nitric acid, sp. gr. 1·20, evaporated to dryness, and heated in air-bath to 120° to 130° C. several hours, re-dissolved in hydrochloric acid, reduced with ammonium bisulphite: precipitate the phosphoric acid by a basic acetate separation, boil the filtrate twice for further precipitates, making three in all, dissolve the combined precipitates in hydrochloric acid, filter out silica, oxidise solution with nitric acid, precipitate with ammonia, re-dissolve the precipitate in nitric acid, and precipitate with ammonic molybdate. This last precipitate is re-dissolved in ammonia and re-precipitated by nitric acid, is then filtered on a Gooch crucible, dried and weighed, and afterwards checked by precipitation as ammonic-magnesic phosphate.

cipitated with ammonium molybdate, finally weighing the yellow precipitate. The result I obtained by this method, was 0·122 per cent, which is a very satisfactory confirmation of the statement the experiment was meant to verify. The time taken in this determination was about from 5 to 6.30 p.m. one evening, by which time I had the yellow precipitate formed,* and the time necessary to filter and weigh the precipitate the next day, perhaps an hour more.

This result being so satisfactory I treated some filings of a high phosphorus pig (in which by my ordinary method I had found 0·826 per cent) in the same manner, but found that I had only succeeded in obtaining 0·580 per cent, or about five-sevenths of the total amount present. I also prepared a button of very high phosphorus iron, and on treating in the same way found that I only obtained about three-quarters of the amount present. This made me think that probably the loss was due either to the escape of phosphuretted hydrogen or to the formation of some other compound than phosphoric acid. I therefore arranged a simple apparatus, the same, in fact, which I use for the determination of sulphur in iron, which is filled with an atmosphere of hydrogen throughout the operation, and consists of a flask A to hold the acid, a flask B for the iron, and flasks C and D, of which C is generally left empty to catch condensed steam, and the two flasks D contain the absorbent liquid.



The absorbent liquid in D was a solution of potassium permanganate acidified with nitric acid. The iron having been placed in B, and the necessary amount of dilute hydrochloric acid to dissolve it in A, the whole apparatus was filled with hydrogen, a current of which was kept passing through the whole time. When the air was all expelled the flask A was inverted above the level of B, so that its contents flowed into B and the solution of the iron commenced. The solution was heated to boiling for some minutes, and when all had dissolved, with the exception of the insoluble portion, the apparatus was disconnected, the insoluble residue filtered from the solution, the solution divided into equal parts, one of which was oxidised with nitric acid and treated as in an ordinary determination of phosphorus, while the other was immediately precipitated by basic acetate, as in the first experiment described.† The amounts of phosphorus found in the prepared iron phosphide were distributed as below.

		Per cent.	Per cent
In residue		3·79	
In solution	oxidised with nitric acid	2·66	
	basic acetate direct		2·16
In gas		0·05	
		6·50	

Showing a loss of 0·50 per cent of phosphorus in the solution in some other form than phosphoric acid. It is very possible that nitric acid fails to oxidise to phosphoric acid all the phosphorus compounds formed in the solution. Referred to the total amount of phosphorus found (6·50 per cent) the distribution per cent is as follows:—

In residue	58·31
Recovered from basic acetate precipitation	33·23
Loss	7·69
In gas	0·77

I repeated the above process on a sample of pig-iron said to contain 0·885 per cent phosphorus, and in which, by my usual method, I found 0·880 per cent weighing as magnesia pyrophosphate, or, calculating from the weight of the yel ow precipitate, 0·878 per cent. This was also conducted in a hydrogen atmosphere. The gas was caught in permanganate acidified with sulphuric acid in the first flask and with nitric acid in the second. Nearly all the phosphorus in the gas was retained in the first flask, a very small amount only passing over to the second. The results obtained were—

Phosphorus in residue		0·345	p.c.
In solution	basic acetate precipitate	0·451	,,
	loss	0·065	,,
In gas		0·019	,,
		0·880	,,

The distribution of the phosphorus is—

In residue		39·11	p.c.
In solution	basic acetate precipitate	51·13	,,
	loss	7·60	,,
In gas		2·16	,,
		100·00	

I then took a sample of high phosphorus pig in which I had found in the usual way 1·45 per cent (weighed as yellow precipitate), or 1·48 per cent (weighed as magnesia pyrophosphate), and dissolved 1 grm. in 10 c.c. hydrochloric acid and 30 c.c. water, finally heating the solution to boiling. This time, instead of a stream of hydrogen being passed through the apparatus, a stream of oxygen was employed. The escaping gas was passed through permanganate and nitric acid. All the phosphorus caught was found in the first flask.

The residue, as in all these experiments, was heated with nitric acid and potassium chlorate; the solution was partially oxidised with 10 c.c. permanganate (1 c.c. = 0·1 Fe) and precipitated as basic acetate as usual; the silica separated from both portions, and the phosphorus determined. The total amount of phosphorus found was 1·42 per cent weighed as magnesia pyrophosphate, or 1·37 per cent weighed as the yellow precipitate, showing a loss of 0·06 per cent. The distribution of the phosphorus was—

In residue		37·47	p.c.
In solution	basic acetate precipitate	55·20	,,
	loss	4·05	,,
In gas		3·28	,,
		100·00	

I next took 2 grms. of the 0·880 to 0·885 per cent pig and dissolved it, as in the last case, in a stream of oxygen,

* I did not seek to remove silica by evaporation to dryness. Per cent Si = 0·151.

† Care being taken to remove silica wherever present.

but, instead of following up each portion separately, mixed them all together (the gas was caught in sulphuric acid permanganate), and collected the residue with the first basic acetate precipitate, treated with nitric acid and potassium chlorate, and proceeded as before. The phosphorus found was only 0·771 per cent, or of the total amount present, 87·41 per cent was found and 12·59 per cent lost.

I repeated the last experiment, using, however, dilute sulphuric acid in place of hydrochloric as the solvent, a stream of oxygen passing continually through, and the solution being kept boiling for fifteen minutes, after all visible action had ceased. The total phosphorus found was 0·767 per cent, distributed as follows:—

In residue		14·17
In solution	basic acetate precipitate	70·86
	loss	13·16
In gas		1·81
		100·00

(To be continued).

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Saturday, May 1, 1886.

Sir FREDERICK BRAMWELL, F.R.S., Honorary Secretary and Vice-President, in the Chair.

The Annual Report of the Committee of Visitors for the year 1885, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to above £85,000, entirely derived from the contributions and donations of the members.

Twenty-six new Members paid their Admission Fees in 1885.

Sixty-three lectures and nineteen evening discourses were delivered in 1885.

The books and pamphlets presented in 1885 amounted to about 354 volumes, making, with 464 volumes (including periodicals bound) purchased by the Managers, a total of 818 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committee of Managers and Visitors, and to the Professors for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year:—

President.—The Duke of Northumberland, K.G., D.C.L., LL.D.

Treasurer.—Henry Pollock.

Secretary.—Sir Frederick Bramwell, F.R.S.

Managers.—Sir Frederick Abel, C.B., D.C.L., F.R.S.; Sir William Bowman, Bart., LL.D., F.R.S.; Joseph Brown, Q.C.; Sir James Crichton Brown, M.D., LL.D., F.R.S.; William Crookes, F.R.S.; Henry Doulton; Sir William Withey Gull, Bart., M.D., D.C.L., F.R.S.; Right Hon. The Lord Halsbury; William Huggins, D.C.L., LL.D., F.R.S.; Alfred Bray Kempe, M.A., F.R.S.; Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S.; Hugo W. Müller, Ph.D., F.R.S.; Sir Frederick Pollock, Bart., M.A.; John Rae, M.D., LL.D., F.R.S.; Lord Arthur Russell.

Visitors.—Shelford Bidwell, M.A.; Stephen Busk; Michael Carteighe, F.C.S.; Arthur Herbert Church, M.A., F.C.S.; Vicat Cole, R.A.; William Henry Domville; James Edmunds, M.D., F.C.S.; Charles Hawksley M.I.C.E.; Alfred Gutteres Henriques, F.G.S.; David Edward Hughes, F.R.S; George Matthey, F.R.S.; John W. Miers; Lachlan Mackintosh Rate, M.A.; William Chandler Roberts-Austen, F.R.S.; Alexander Siemens.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 16, April 19, 1886.

Do the Fluorescences of Zα and Zβ belong to different Earths?—Lecoq de Boisbaudran.—See p. 217.

The Yα of M. de Marignac is definitively named Gadolinium.—Lecoq de Boisbaudran.—M. de Marignac has requested the author to announce to the Academy that he has selected the name gadolinium—symbol Gα—for the metal of Yα.

Thermo-Electricity of Silver Iodide.—H. Le Chatelier.—As a sequel to the sudy of the dimorphism of silver iodide undertaken by the author and M. Mallard he has now examined the corresponding variations in the thermo-electric properties of this body. Melted silver iodide was run in a thin sheet between two silver crucibles, the one containing paraffin and the other water, the temperature of which could be made to vary at pleasure. Each crucible was connected to one extremity of a Deprez D'Arsonval galvanometer. The cubic silver iodide has a much greater conductivity than the hexagonal variety.

On Ammonium Vanadiates.—A. Ditte.—The author describes five of these salts, a neutral or mono-vanadiate, a sesqui-salt which contains 4 or 6 mols. of water according to the temperature at which they are deposited, a di-salt, containing 3 mols. of water, and two tri-salts, a yellow and a red modification, the former of which is the most stable and the most readily formed of all the acid vanadiates. The red salt contains 5 mols. of water. The ammonium vanadiates may be divided into two groups; the former hydrated, deep red, and very soluble in water; the other group anhydrous, slightly coloured, and sparingly soluble. The properties of these bodies seem connected respectively with those of vanadic acid, the soluble red salts containing the soluble variety of this acid, whilst the slightly coloured and slightly soluble compounds contain the polymerised variety which is only sparingly soluble in water.

Transformation of Chromium Monochloride into Sesquichloride. Mechanism of the Solution of Anhydrous Chromium Sesquichloride.—M. Recoura.—The transformation may be effected either by oxidising the monochloride with free oxygen, so as to form the oxychloride, and treating the latter compound with hydrochloric acid. If the solution of monochlotide is saturated the blue-grey sesquichloride is obtained, a blue-grey powder containing 13 mols. of water. The second process consists in passing a current of air into a refrigerated mixture of the solid monochloride and of hydrochloric acid from which the green sesquichloride is precipitated by means of a current of gaseous hydrochloric acid. A third process is to form a dilute solution of chromium monochloride and to pass into it a current of chlorine free from oxygen.

An Acid Fermentation of Glucose.—M. Boutroux.—The ferment required is a micrococcus much resembling *M. oblongus*. It acts only upon glucose. The author describes the calcium, strontium, and cadmium salts of the acid. The comparison between this acid and the hexepic acid of M. Maumené is difficult.

Biedermann's Central Blatt fur Agrikultur Chemie. Vol. xv., Part 1.

Injury to Fisheries and Fish-Culture by Sewage and Industrial Waste Waters.—C. Weigelt, O. Sacre, and L. Schwab.—The authors have made a series of very valuable experiments on this subject, which in England would have been rewarded with heavy fines, if not with imprisonment. They find that chloride of lime in proportions of 0·04 to 0·005 per cent chloride have an immediate deadly action upon tench, whilst trout and salmon perish in presence of 0·0008 per cent of chlorine. Sulphurous acid has the same action as chlorine, and is still more hurtful if another acid is simultaneously present. Sulphites are harmless. Hydrochloric acid, 1 per cent, kills tench and trout. In sulphuric acid of 0·1 per cent trout turn on their sides in two to six hours, whilst tench were not affected in eighteen hours. Acids are said to have less action the higher are their molecular weights (?) Tannin at 0·1 per cent is harmless. Ammonia exerts no action at 0·01 per cent. Soda at 1 per cent is fatal to trout on prolonged exposure. Manganese chloride at 5 per cent had no action on tench in twenty-two hours, and a trout sustained 1 per cent for five hours. Iron acts as a specific poison upon fishes, not only in the state of a ferrous salt. Alum has the same injurious action as the salts of iron. Solution of caustic lime has an exceedingly violent action upon fishes, due in part to the deposition of calcium carbonate in the gills. Arsenious acid, 0·1 per cent, combined with soda has no injurious action upon trout and tench. Mercuric chloride in proportions of 0·1 and 0·05 per cent, is immediately fatal. Copper sulphate, 0·1 and 1·0 per cent, kills trout in a few minutes if they cannot escape into pure water. Potassium cyanide, 0·01 and 0·005 per cent, is rapidly fatal if there is no escape. Potassium sulphocyanide and ferrocyanide in the proportion of 1 per cent had no injurious action in an hour. Sodium sulphide, 0·1 per cent, was endured by tench for thirty minutes. The fish were strongly bleached and did not recover their colour in pure water. Hydrogen sulphide proved rapidly fatal in the proportions of 0·01 and 0·001 per cent. The hurtfulness of putrid sewage depends on poisonous gases, on the deficiency of oxygen, and on the action of bacteria.

Natural Enemies of Rimpau's "Moor-dam" Cultivation.—M. Fleischer and others.—This voluminous memoir does not admit of useful abstraction.

Preservation of Farm-Yard Manure.—Hickethier and Holdefleiss.—Such manure in course of time loses nearly one-third of its organic matter. This loss is reduced by the presence of phosphatic gypsum, but is still considerable. Kainit reduces the loss still further

Gilchrist Slags and their Importance for the Manure Trade.—Prof. Wagner.—At present prices finely ground slags are very advantageous as compared with superphosphate. The Gilchrist precipitates and the Gilchrist superphosphate have no future, as their market value does not cover the cost of production.

A Manurial Experiment with Gilchrist Slag on Oats.—H. Bieber.—The ground slag should be applied to the soil as early as possible.

Animal and Vegetable Pepsine.—O. Schade.—Papayine, the only vegetable pepsine hitherto obtained, is moderately widely diffused and occurs in the so-called carnivorous plants.

Calorimetric Researches.—Prof. F. Stohmann and M. Rübner.—From the *Journal für Prakt. Chemie* and the *Zeitschrift für Biologie*.

The Changes in Fodder Plants in Silos.—Prof. Kellner and J. Sawano.

Utilisation of Certain Foods in the Human Digestive System.—H. Malfatti.—The author's experiments refer to maize-meal alone, in conjunction with butter and with cheese. The latter admixture gave the best results.

Experiments with Sheep on the Digestibility of certain Foods.—Dr. O. Kellner.—Not capable of useful abstraction.

Nitrogenous Ingredients of Pumpkin Seedlings.—E. Schulze.—From the *Journal für Prakt. Chemie*.

Amphoteric Reaction of Plant-Juices.—C. Kraus.—It was found in twenty-one different species of plants that the juices of the pith-parenchyma may be either purely acid, purely alkaline, or amphoteric.

Comparative Researches in various Plant-Seeds on the Formation of Amides on Germination in the Dark.—Drs. Schulze and Flechsig.—In the cereals the order of succession according to the strength of the formation of amide is: rye, oats, barley, wheat. Plant-seeds do not produce quantities of amides proportional to their nitrogenous reserves.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin Vol. xix., No. 2.

Abscission of Hydrocarbons from the Aromatic Sulpho-Acids by means of Superheated Steam.—Werner Kelbe.—The author refers to the researches in this direction of H. E. Armstrong (*Chem. Soc. J.*, 1884, i., pp. 148 to 153) and K. E. Schulze (*Berichte*, xvii., p. 2862) and states that by using superheated steam instead of steam at 100° he has not only succeeded in splitting off the hydrocarbons from the salts of all the aromatic sulphonic acids—adding the necessary quantity of sulphuric acid—but also of decomposing the free dry sulphonic acids in an analogous manner.

On β-Benzoyl-isosuccinic Acid.—C. A. Bischoff.—The synthesis of this acid, described by W. Knes and C. Paal (*Berichte*, xviii., 3323), was effected by the author three years earlier, and is communicated in *Berichte*, xvi., p. 1044.

Chemical Composition of certain Rare Minerals from Hungary.—L. Sipöcz.—The author describes the sylvanite of Offenbanya, the krennerite and nagyagite of Nagyag, the wolframite of Felsöbánya, the wehrlite of Deutsch-Pilsen, the nickel ore of Urawitza, the grey nickel ore and the red nickel of Dobsina, the semseyite of Felsöbánya, the zinc-blendes of Kapnik, Nagyag, Rodna, and Schemnitz, and the bournonite of Nagyag. None of these minerals contain any rare or novel elements.

The Condensation-Products of Pyrrol with Alloxan.—G. Ciamician and P. Magnaghi.—The authors obtain a pearl-grey crystalline substance, insoluble in ether, benzol, petroleum ether, and cold water, but soluble in boiling water with a blue colour. Its composition is the sum of a mol. pyrrol and a mol. of alloxan.

Bases of Methyl Violet and of Magenta.—H. Wichelhaus.—Methyl violet prepared from pure dimethylaniline is a mixture containing among other bases that which was first formed by the action of chloranil upon dimethylaniline, and is distinguished by its crystalline tendency; a non-crystalline product, insoluble in petroleum ether, and soluble in hydrochloric acid with a reddish violet colour.

Supposed Error in working with the Nitrometer.—G. Lunge.—A reply to Mr. T. Bayley's paper (Chem. News, vol. liii., p. 6). If on repeating Bayley's experiment the beaker is well washed out before pouring in the water for the dilution of the nitrometer acid, no more gas is obtained in the nitrometer, but if this precaution is entirely or partially omitted (and it is not mentioned by Bayley) occasionally much more gas may be obtained.

Contributions to a Knowledge of the Alkylendiamines.—A. T. Mason.—The author examines in how far the reactions of ethylendiamine and the kindred diamines agree with those of the aromatic orthodiamines.

A Homologue of Rhodanic Acid.—J. Berlinerblau.—On bringing in contact a strong aqueous solution of

ammonium sulphocyanide with α-chloropropionic acid and applying a gentle heat there is a brisk reaction, and a compound is formed composed of $C_4H_5NS_2O$, iodorous, of a faint yellow colour, and fusible at 123°.

On Rhodanic Acid.—J. Ginsburg and S. Bondzynski.—This very extensive paper does not admit of useful abstraction.

Constitution of Hydrated Salts according to their Vapour-Tension at the Ordinary Temperature.—W. Müller-Erzbach.—An investigation of hydrated haloid salts in continuation of the author's researches published in *Wiedemann's Annalen*, vol. xxiii., p. 607.

Crystals of Venous Hæmoglobine.—M. Neucki and N. Sieber.—The crystals appear as hexagonal plates, some of which have the size of 2 to 3 m.m. In the microspectroscope each crystal displays only the one band of reduced hæmo-globine. The prismatic crystals are doubly refractive.

Alfred Einhorn's Memoir "On an Aldehyd of the Chinoline Series containing the Aldehyd Group in the Pyridin-Nucleus."—W. v. Miller and J. Spady.—The authors point out the discrepancies of their results (*Berichte*, xviii., p. 3402) and those of Einhorn (*Berichte*, xviii., 3465).

On α-Chlorophthalic Acid.—J. Guareschi.—This acid forms long colourless silky needles, fusible at 184°; 2·16 parts of the acid dissolve in 100 parts water at 14°.

Notes.—E. Noelting.—These notes refer to α-iodonaphthaline, trinitro-metacresol, the identity of isorcine and cresorcine, and the nitration of benzylchloride.

On Xylidine-sulphonic Acids.—E. Noelting and O. Kohn.—The substance of this paper has been already published in the *Transactions of the Société Industrielle de Mulhouse* as far back as 1883.

Nitro-derivatives of Paraxylol.—E. Noelting and C. Geissmann.—An investigation into the constitution of the two dinitro-paraxylols. The authors have arrived at the same conclusions as Lellmand, whose researches have, in their opinion, decided the question.

On Meta- ann Para-phenylen-diphenylketon.—E. Noelting and O. Kohn.—These compounds are also known as iso-and terephthalophenon. Both these bodies are diketones and not lactones. It seems probable to the authors that all bibasic acids in which two carboxyls are connected to adjacent atoms of carbon form non-symmetric chlorides.

Azo-derivatives of Metaxylenol.—E. Grevingk.—If metaxylenol is brought in contact with diazobenzolchloride in an alcoholic solution there is formed a brown-red tarry mass, which after re-crystallisation appears in the form of brownish red crystals, phenyl-azometaxylenol—and ortho-oxyazo-compound. Its sulpho-acid dyes wool and silk a brownish yellow in an acid bath.

On Ethyl-paraphenylen-diamine.—W. Schweitzer.—This compound was obtained as a pale yellow, inodorous oil, turning brown and thick on exposure to the air. Its boiling-point at a pressure of 746 m.m. is between 261° and 262°. The base is readily soluble in benzol, alcohol, and ether, less readily in water. If oxidised along with phenoles, ethyl-paraphenylen-diamine yields fine colouring-matters of the indophenol class. That obtained from phenol forms a deep blue powder, and in a curdled soap-beck dyes silks a fine dark blue. With α-naphthol there is formed an analogous colour, which dyes silk a dark cornflower blue. The colour obtained from β-naphthol dyes a more reddish shade, whilst the oxidation-product from resorcine gives a black-blue.

On the Safranines.—W. Schweitzer.—The author describes two isomeric compounds, α- and β-ethylsaffranine. The former is obtained by taking 10·4 grms. of ethyl-paraphenylen-diamine and 12·7 of aniline, both as hydrochlorates, dissolving in 700 c.c. of water, and heating to a boil, with the addition of a little glacial acetic acid. The mixture is stirred and a solution of potassium dichromate, containing 40 grms. per litre, is gradually added. From time to time small portions are taken out of the vessel and moistened with a drop of the oxidising agent upon filter-paper. The colour of the mixture is at first blue, then green, and passes to a reddish violet. A red colour along the margins of the vessel shows the formation of saffranine. After the consumption of 400 c.c. of the bichromate solution a portion of the mixture when touched with a drop of the bichromate remained unchanged. Milk of lime is then added and the red solution of saffranine is separated by filtration from the dark residue and from a violet colouring-matter. The liquid is evaporated to dryness and the colouring-matter is extracted with absolute alcohol at a boil. The β-modification is made with 10·8 grms. paraphenylen-diamine, 7·7 grms. aniline, and 12·3 grms. ethyl-aniline dissolved as hydrochlorates in 500 c.c. water and treated as above. The two ethyl-saffranines are not identical. The isomerism of the colouring-matters appears in particular after they have been fixed upon silk. If silk is dyed with the two hydrochlorates in a curdled soap-beck under the same conditions the tinctorial power of α is found decidedly greater than that of β. The α variety dyes darker with a bluish cast; whilst the β gives lighter, more yellowish tones.

On the Hydroxylamine Reaction.—F. Münchmeyer.—The author obtains results differing from those of Noelting and Kohn, reproduced in No. 1 of the *Chemiker Zeitung* of this year (Jan. 3) from the *Transactions of the Industrial Society of Mulhouse*.

Specific Rotatory Power and Crystalline Form of Glucosamine Hydrobromate.—F. Tiemann.—The results are given in the form of tables.

Alleged Optical Rotatory Power of Picoline.—H. Landolt.—The author's results show the inactivity of picoline. The rotatory angle of from 0·26° to 1° found by Hesekiel and Wiedel lies within the limit of possible error.

The Trioxime of Phloroglucine.—Adolf Baeyer.—Benzol derivatives can be converted into derivatives of hexa-hydrobenzol, not merely as it was supposed by the addition of chlorine, hydrogen, &c., but by simple translocation.

On Juglon.—August Bernthsen and August Semper.—Not suitable for abstraction.

Action of Bromine and Water upon Levulose.—M. Honig.

Action of Caustic Potassa upon Boiling Pyrrol.—G. Ciamician and M. Donnstedt.—The result is the formation of pyrrol potassium, as it was found some years ago by Anderson, though the observation has remained unnoticed. Caustic soda under the same conditions has no action upon pyrrol.

On Meta-nitro-paratolyl-glycine, its Reduction-Product, "Oxy-dihydro-toluquinoxaline," and Meta-nitro-paratoluylic Nitrile.—R. Leuckart.—The author announces that A. Herrmann, in the laboratory of Göttingen University, has been engaged with researches similar to those of O. Hinsberg before the first results of the latter were published.

Certain Derivatives of β-Naphtho-quinone.—R. Koreff.—The author examines the silver salt of β-naphthoquinon-dioxime, mono-methyl-ether, the α-methyl-ether of β-naphtho-quinon-dioxime, the action of hydroxylamine upon the methyl-ether of β-nitroso-α-naphthol, the reduction of β-naphtho-quinon-dioxime, diphenyl-naphthoquinoxaline, diphenylen-naphthoquinoxaline, the oxidation of β-naphtho-quinon-dioxime, and the oxidation of β-diphenyl-glyoxime.

A Disulph-acid of Thiophene and the Corresponding Dicarbonic Acid.—Hugo Jæckel.—This bulky memoir does not admit of useful abstraction.

Experiments on Hydroxylisation of Pyridin-Derivatives in the Lateral Chain.—J. Messinger.—The author has studied the action of hypochlorous acid upon non-saturated compounds of the pyridin series in order to arrive at hydroxylised pyridin derivatives in the lateral chain, as such bodies might be closely related to certain alkaloids.

On Meta-nitro-dimethyl-aniline, Meta-nitro-diethyl-aniline, and their Reduction-Products.—A. Groll.—The author studies here the nitration of dimethylaniline and diethylaniline, and the action of nascent hydrogen upon meta-nitro-dimethylaniline and meta-nitro-diethyl-aniline.

MISCELLANEOUS.

Course of Practical Geology.—Prof. H. G. Seeley, F.R.S., is about to conduct a course of Field Lectures on Saturday afternoons for practical study of the geology of the country round London. This course is given at the request of students of the University Extension Lectures, and information concerning places to be visited may be obtained from Mr. Nicol Brown, 7, Princess Road, Brownswood Park, South Hornsey, N.

New Method of Preserving and Economising Hops Destined for Use in Breweries.—Louis Bouté.—The author's process consists in the mechanical separation of the lupuline, which adheres to the base of the bracts forming the cone of the hop-flower; in obtaining from the bracts thus deprived of lupuline an extract by lixiviation with boiling distilled water. This extract is then dried in a vacuum at a low temperature and is then intimately mixed with the powdered lupuline.—*Comptes Rendus*, vol. cii., No. 14.

On the Cerium Tungstates and Chlorotungstates.—P. Didier.—The action of sodium tungstate upon melted cerium chloride gives rise, not to crystalline sodium tungstate, but to a series of chlorinated compounds, the cerium chlorotungstates. True cerium tungstates were obtained by taking an acid sodium tungstate in a state of fusion and throwing into it ceroso-ceric oxide in small portions, not sufficient to neutralise the excess of acid. A crystalline powder is then separated by water, consisting of octahedra very analogous to the crystals of Scheelite. The author has obtained cerium molybdate in an analogous manner, but he has not succeeded in obtaining a definite cerium chloro-molybdate.—*Comptes Rendus*, vol. cii., No. 14.

MEETINGS FOR THE WEEK.

MONDAY, 10th.—Society of Arts, 8. (Cantor Lectures). "Animal Mechanics," by Dr. B. W. Richardson, F.R.S.
TUESDAY, 11th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "Japanese Art Work," by Ernest Hart.
WEDNESDAY, 12th.—Society of Arts, 8. "The Proposed Fishery Board," by J. W. Bund Willis-Bund.
—— Geological, 8.
—— Microscopical, 8.
THURSDAY, 13th.—Royal, 4.30.
—— Mathematical, 8.
—— Royal Institution, 3. "The Alkaloids," by Prof. Dewar, F.R.S.
—— Society of Arts, 8. "The Scientific Development of the Coal-Tar Colour Industry," by Professor R. Meldola.
FRIDAY, 14th.—Royal Institution, 9. "Suspended Crystallisation," by Prof. J. M. Thomson.
—— Quekett Club, 8.
—— Astronomical, 8.
SATURDAY, 15th.—Royal Institution, 3. "How to Form a Judgment on Musical Works," by Prof. Ernst Pauer.
—— Society of Arts, 3. "Electricity," by Professor George Forbes.

TO CORRESPONDENTS.

C. C. Robertson.—Lomas, "Manual of Alkali Trade" (Crosby Lockwood and Co.), and Lunge's great work on "Sulphuric Acid and Alkali," vol. iii. (Van Voorst), give full information on bicarbonate of soda. Epsom salts are briefly described in "Ure's Dictionary." They are not mentioned in "Spon's Encyclopædia," and we do not even know of a German work which goes into their manufacture.

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MANCHESTER CORPORATION GAS-WORKS.

TAR AND AMMONIACAL LIQUOR.

The Gas Committee of the Manchester Corporation are prepared to receive Tenders for the purchase and removal of the Tar and Ammoniacal Liquor to be produced at their Droylsden Station during the period of one or more years from the 24th June next. The Committee do not bind themselves to accept the highest or any Tender. Sealed Tenders, addressed to the Chairman of the Gas Committee and endorsed "Tender for Tar and Liquor, Droylsden," must be delivered at the Offices of the Gas Department, Town Hall, on or before Monday, the 24th day of May next. Forms of Tender and further particulars may be obtained on application in writing to Mr. CHARLES NICKSON, Superintendent of the Department.

By order of the Gas Committee,
Town Hall, April 30, 1886. JOS. HERON, Town Clerk.

MANCHESTER CORPORATION GAS-WORKS.

SPENT OXIDE.

The Gas Committee of the Corporation of Manchester are prepared to receive Tenders for the purchase and removal of the Spent Oxide to be produced at their Gaythorn, Rochdale Road, and Bradford Road Works during a period of one, two, or three years, from the 30th June next. The Committee do not bind themselves to accept the highest or any Tender. Sealed Tenders, addressed to the Chairman of the Gas Committee and endorsed "Tender for Spent Oxide," must be delivered at the Offices of the Gas Department, Town Hall, on or before Monday, the 24th day of May next. Forms of Tender and further particulars may be obtained on application in writing to Mr. CHARLES NICKSON, Superintendent of the Gas Department.

By order of the Gas Committee,
Town Hall, April 30, 1886. JOS. HERON, Town Clerk.

THE WORCESTER CHEMICAL MANURE WORKS, DIGLIS, WORCESTER.

Messrs. FULLER, HORSEY, SONS, and CASSELL are instructed to SELL by AUCTION, at the Mart, Tokenhouse Yard, London, E.C., on Wednesday, June 9th, at 2 precisely, the WORCESTER CHEMICAL WORKS, Diglis, situate on the banks of the Worcester and Birmingham Canal, close to its junction with the River Severn. The buildings are of modern construction and well arranged, and comprise a brick-built factory and manure store, over which are three large lead chambers, with match-boarded enclosure and slated roof, a Gay-Lussac tower, 60 ft. high, and a Glover's tower, 55 ft. high, large ranges of stores, grinding room, steam-engine and boiler houses, chimney shaft, offices, and laboratory. The plant and machinery include two Carr's patent disintegrators, phosphate breaker, five pairs 4 ft. 6 in. French burr mill stones, two steam engines and boilers, and the necessary appliances for carrying on a large business. The works are capable of turning out 50 tons per diem, and barges of 108 tons can load alongside. They are held for an unexpired term of about 70 years at low rents amounting to £92 8s. per annum, and the total area is upwards of an acre. Possession will be given on completion of the purchase. May be viewed by orders to be obtained of the Auctioneers; and particulars, with plans, may be had of Messrs. John Stallard and Son, Solicitors, Worcester; Messrs. Stallard and Turner, Solicitors, 44, Bedford Row, W.C.; of Messrs. Webb and Exton, Surveyors, The Avenue, Cross, Worcester; at the Mart; and of Messrs. Fuller, Horsey, Sons, and Cassell, 11, Billiter Square, London, E.C.

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THE CHEMICAL NEWS.

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ELECTROLYTIC CONDUCTION IN RELATION TO MOLECULAR COMPOSITION, VALENCY, AND THE NATURE OF CHEMICAL CHANGE:

Being an Attempt to apply a Theory of "Residual Affinity."*

By HENRY E. ARMSTRONG Ph.D., F.R.S.

In my recent address to the Chemical Section of the British Association at Aberdeen I have specially called attention to the "affinity" of *negative* elements—chlorine, oxygen, sulphur, &c.—for negative elements; and I have sought to show that the formation of so-called *molecular compounds* is largely, if not entirely, an outcome of this peculiarity of negative elements. I have also ventured to suggest "that in electrolysing solutions the friction arising from the attraction of the ions for each other is perhaps diminished, not by the mere mechanical interposition of the *neutral* molecules of the solvent—in the manner suggested by Kohlrausch—but by the actual attraction exercised by these molecules upon the negative ion in virtue of the affinities of the negative radicles." In this passage I but vaguely hinted at a modification of the current theory of electrolysis which had occurred to me; as further consideration of the question, especially of Ostwald's electro-chemical studies, has strengthened my views, I am led to think that it may be justifiable to submit them for discussion.

It is usual to divide bodies into three classes according to the mode in which they are acted on by an electromotive force: metals forming one class, electrolytes a second, and dielectrics a third. In making this division perhaps the fact is not sufficiently borne in mind that some compounds — silver chloride for example — are *per se* electrolytes, while others—such as hydrogen chloride and water—are *individually* dielectrics, but behave as electrolytes when conjoined. On this account it appears to me desirable to distinguish between—

(*a*) *Metals.*

(*b*) *Simple* electrolytes—compounds, like silver chloride which in the pure state are electrolytes.

(*c*) Pseudo-dielectrics—compounds which, like water, hydrogen chloride, and sulphuric acid behave as dielectrics when *pure*, but as electrolytes when mixed with other members of their own class. Conducting mixtures of members of this class may conveniently be termed *composite electrolytes.*

(*d*) Dielectrics.

Simple Electrolytes.

It is undoubtedly a fact that only a limited number of binary compounds are simple electrolytes; and it is especially noteworthy that, with the single doubtful exception of liquefied ammonia, no hydrogen compound—whether binary or of more complex composition—can be classed with the simple electrolytes. Indeed, all the simple electrolytes with which we are acquainted are either compounds such as the *metallic* chlorides or *metallic* salts—nitrates, sulphates, &c. Including metallic chlorides and their congeners and the corresponding oxides and hydroxides among salts—regarding water as an acid, in fact—and denying the title of salts—hydrogen salts—to the acids, Hittorff's proposition (*Weid. Ann.*, 1878, iv., 374): "Electrolyte sind Salze" may be safely upheld. But only some of the binary metallic salts are electrolytes; beryllium chloride, for example, belongs to the class of "pseudo-dielectrics" (Nilson and Petterson, *Wied. Ann.*, 1878, iv, 565; Humpidge, *Phil. Trans.*, 1883, 604); and in the case of those elements which readily form two classes of salts—so-called *ous* or *proto*-salts and *ic* or *per*-salts, the *ous* compounds alone appear to be electrolytes.

It is highly remarkable that whereas fused silver chloride is easily decomposed on passage of a current of low electromotive force, hydrogen chloride is a "pseudo-dielectric" which forms, when coupled with the "pseudo-dielectric" water a readily conducting "composite electrolyte," while mercuric chloride conducts with great difficulty—possibly not at all when pure—not only in the fused state, but even when coupled with water. No explanation of these facts seems to be afforded by thermo-chemical data.*

The consideration of these and other similar cases, I think, can but lead to one conclusion: that electrolysability is conditioned both by the nature of the elements in the compound and its molecular structure. I have put forward the hypothesis in my address—"that among metallic compounds only those are electrolytes which contain more than a single atom of metal in their molecules." The mere presence of two or more associated atoms of metal in the molecule, however, probably does not constitute a compound an electrolyte; and although the hypothesis may be applicable to the majority of simple electrolytes, it certainly does not appear to include all the facts, and it does not serve to explain why certain salts are electrolytes while others are not.

The remarkable difference in the electrical behaviour of two compounds of the same element, such as stannous chloride, in which the ratio of tin to chlorine atoms is as 1 to 2, and stannic chloride, in which Sn : Cl = 1 : 4—the one being a simple electrolyte, the other a pseudo-dielectric—if indeed it be not a dielectric—would appear almost to justify the conclusion that, in the case of per-salts such as stannic chloride, the metal is, as it were, enveloped in a non-conducting sheath of the negative radicle. But whether this be so or not, if—as appears to be the case—all simple electrolytes are *metallic* compounds, and if only proto-salts are electrolytes, may it not be that electric conduction in simple electrolytes is of the nature of ordinary metallic conduction, differing from it only in the circumstance that the compound is decomposed as a consequence of the passage of the current?

This would lead to the conception of an electrolyte as being a metallic compound of such elements, and so constituted that electric conduction may take place through its mass in a manner similar to that in which it takes place through a mass of metal: in fact through the agency of its metallic atoms. On this view, it is essential that the metallic atoms in the molecules comprising a mass of an electrolyte should be in proximity—as they probably are in proto-salts, but not in many per-salts. The conductivity of two-metal alloys is in many cases much less than that of either of the contained metals: for example, the conductivity of the alloy $SnCu_4$ is about $\frac{1}{4}$th that of tin and about $\frac{1}{10}$th that of copper. The specific conductivity of metals may, therefore, be much reduced by

* A Paper read before the Royal Society, March 25th, 1886.

* The following numbers are given by Thomsen as representing the amounts of heat developed in the formation of the specified chlorides in the state of aggregation in which they exist under ordinary conditions (2 × 35·4 grms. of chlorine being in each case used in the production of the chloride):—

Hydrogen chloride	..	..	44,000 units (grm.° C.).
Silver	,,	.. ..	58,760 ,,
Mercuric	,,	.. ..	63,160 ,,
Stannic	,,	.. ..	63,625 ,,
Stannous	,,	.. ..	80,790 ,,
Lead	,,	.. ..	82,770 ,,

Only three of the chlorides in this list are simple electrolytes. As much more heat is developed in the formation of two of these three—stannous and lead chlorides—than in the case of any of the others, it would appear probable *à priori* that these would be the most stable; obviously, therefore, the study of the heats of formation throws no light on differences in electrical behaviour such as are manifest between hydrogen, mercuric and stannic chlorides, on the one hand, and silver, stannous and lead chlorides on the other.

association with one another; and this being the case, it appears probable that the specific conductivity of a metal would be still more reduced by association with a non-metal, and that if the metal were one of low specific conductivity, it might thus practically become altogether deprived of conducting power; perhaps the exceptional behaviour of mercuric and beryllium chlorides is to be explained by considerations such as these.

To discuss such questions at all satisfactorily, however, we require to know much more of the electrical behaviour of *pure* fused salts; it is surprising how little accurate knowledge we possess on this subject.

Composite Electrolytes.

I assume it to be admitted that neither water nor liquid hydrogen chloride, for example, is an electrolyte, although an aqueous solution of hydrogen chloride conducts freely, and is electrolysed by an electromotive force of but little more than a volt.

The theory put forward by Clausius in 1857, in explanation of electrolysis, is well stated in Clerk Maxwell's "Elementary Treatise on Electricity" (p. 104), in the following words:—

"According to the theory of molecular motion every molecule of the fluid is moving in an exceedingly irregular manner, being driven first one way and then another by the impacts of other molecules which are also in a state of agitation. The encounters of the molecules take place with various degrees of violence, and it is probable that even at low temperatures some of the encounters are so violent that one or both of the compound molecules are split up into their constituents. Each of these constituent molecules then knocks about among the rest till it meets with another molecule of the opposite kind, and unites with it to form a new molecule of the compound. In every compound, therefore, a certain proportion of the molecules at any instant are broken up into their constituent atoms. Now, Clausius supposes that it is on the constituent molecules in their intervals of freedom that the electromotive force acts, deflecting them slightly from the paths they would otherwise have followed, and causing the positive constituents to travel, on the whole, more in the positive than in the negative direction, and the negative constituents more in the negative direction than in the positive. The electromotive force, therefore, does not produce the disruptions and reunions of the molecules, but finding these disruptions and reunions already going on, it influences the motions of the constituents during their intervals of freedom. The higher the temperature, the greater the molecular agitation, and the more numerous are the free constituents. Hence the conductivity of electrolytes increases as the temperature rises."

This theory has been widely accepted by physicists; but it appears to me that, on careful consideration of the evidence, and especially of recent exact observations on conditions of chemical change, it must be admitted, as I have elsewhere contended (B. A. Address), that proof is altogether wanting of the existence of a condition such as is postulated by Clausius. Moreover, it has been shown by Hittorf that cuprous and silver sulphides, and by F. Kohlrausch that silver iodide, all undergo electrolysis in the *solid* state; the partisans of the dissociation hypothesis would, I presume, scarcely contend that it is easily applicable to such cases as these. It also does not appear to afford any explanation of the abrupt change in conductivity which occurs in solid silver iodide and sulphide as the temperature is raised; nor of the peculiar variation in conductivity on diluting sulphuric acid with water.

Again, I venture to think that the conductivity of a *mixture* of compounds which themselves have little or no conducting power is accounted for in but an unsatisfactory and insufficient manner by the hypothesis put forward by F. Kohlrausch (*Pogg. Ann.*, 1876, 159, 233); there appears to be *far too great a difference* in the behaviour of the pure compounds, water and liquid hydrogen chloride, for example, and of a mixture—no decomposition apparently of either *compound* being effected by any electromotive force short of that which produces disruptive discharge, although the *mixture* of the two will not withstand an electromotive force of little more than a volt. Influenced by these considerations, I am led to conclude that there is no satisfactory evidence that the constituents of the electrolyte are either free prior to the action of the electromotive force, or are primarily set free by the effect produced by the electromotive force upon either member *separately* of the *composite* electrolyte; but that an additional influence comes into play, viz., that of the one member of the composite electrolyte upon the other while both are under the influence of the electromotive force. This influence, I imagine, is exerted by the negative radicle of the one member of the composite electrolyte upon the negative radicle of the other member. Assuming, for example, that in a solution of hydrogen chloride in water the oxygen atom of the water molecule is straining at the chlorine atom of the hydrogen chloride molecule, if when subjected to the influence of an electromotive force the molecules are caused to flow past each other—and the phenomena of electric endosmose afford evidence that in composite electrolytes the molecules are thus set in motion—it is conceivable that this influence, superadded to that of the electromotive force upon the electrolyte, may bring about the disruption of the molecule and conduction: in short, that a state may be induced such as Clausius considers is the state prior to the action of the electromotive force.

A large amount of most valuable information on the connection of dilution and electrical conduction in aqueous solutions has been recently published by Arrhenius, Bouty, F. Kohlrausch, and Ostwald. In his most recent paper Ostwald (*Journal für Praktische Chemie*, 1885, 32, 300) has given the results of his determinations of the *molecular conductivity* m* in the case of no less than about 120 different acids; it appears to me that many—indeed all—of his observations afford most distinct evidence in favour of the view I have expressed above. The general result of his investigation is that the molecular conductivity increases with dilution—in other words, that the dissolved substance exercises a greater specific effect, finally attaining a maximum; it then diminishes, but he believes this to be due to impurities in the water, especially to neutralisation of the acid by traces of ammonium carbonate. The maximum, he appears to think, would be the same for all acids if the dilution could only be pushed far enough; in the case of monobasic acids it is about 90 (arbitrary units); it is twice this in the case of dibasic, thrice in the case of tribasic, and so on.

I will quote first his results in the case of solutions of hydrogen chloride, bromide, iodide, fluoride, and silicon fluoride.

TABLE I.

v.	HCl.	HBr.	HI.	HF.	H_2SiF_6.
2	77·9	80·4	80·4	—	47·81
4	80·9	83·4	83·2	6·54	57·29
8	83·6	85·1	84·9	7·59	62·20
16	85·4	86·6	86·4	10·00	67·08
32	87·0	87·9	87·6	13·14	71·52
64	88·1	88·9	88·7	17·38	75·61
128	88·7	89·4	89·4	23·11	79·22
256	89·2	89·6	89·7	30·30	83·39
512	89·6	89·7	89·7	39·11	91·62
1024	89·5	89·5	89·3	49·49	109·5
2048	89·5	88·9	89·0	59·56	144·0
4096	88·6	87·6	87·8	69·42	187·1
8192	—	—	—	—	226·6
16384	—	—	—	—	258·6
32768	—	—	—	—	282·6

It will be observed that hydrogen chloride, bromide, and iodide practically behave alike; the numbers for the chlo-

* $m=kv$, k being the specific conductivity as ordinarily defined, and v the volume of the solution, *i.e.*, the number of litres containing the formula weight in grms. of the acid. His results are expressed in arbitrary units.

ride are, however, slightly lower than those for the bromide and iodide, and the maximum is not reached quite so soon in the case of the chloride. Hydrogen fluoride is altogether different: its molecular conductivity is exceedingly low to begin with, and is considerably below the maximum even when $v=4092$. But I would call special attention to the numbers for hydrogen silicon fluoride, which is commonly regarded as a dibasic acid; at first, as Ostwald says, it behaves as a monobasic acid of moderate strength—iodic acid, for example; but the maximum for monobasic acids being exceeded, the molecular conductivity increases more and more rapidly, ultimately exceeding the treble value, 270. It must be supposed that it undergoes decomposition in accordance with the equation $H_2SiF_6+2H_2O=SiO_2+6HF$. The noteworthy point is *the large excess of water* required to initiate this change; when $v=16$ the solution contains less than 1 per cent H_2SiF_6, and at this point, according to Ostwald, decomposition probably begins, but that it is far from complete, even when a very much larger excess is present, is evident from the fact that the maximum, when $v=32,768$, is 282, and not above 400.

Now it is well known that hydrogen chloride, bromide, and iodide are, practically speaking, perfect gases under ordinary circumstances: in other words, masses of these gases would mainly consist of molecules such as are represented by the formulæ HCl, HBr, and HI. It has been proved, however, by Mallet that hydrogen fluoride at temperatures near to its boiling-point mainly consists of molecules of the formula H_2F_2. In the aqueous solution the molecules would be brought more closely together, and therefore it is probable that, even in the case of hydrogen chloride, bromide, and iodide, a certain proportion of more complex molecules would result; the relatively high boiling-point of hydrogen fluoride (19·4°) renders it probable that in the liquid state this compound would at least partially consist of molecules more complex even than is represented by the formula H_2F_2. On the hypothesis put forward in this paper, the influence exercised by the one member of the composite electrolyte upon the other member during electrolysis is at all events mainly exercised by their respective negative radicles, and the extent of the influence thus mutually exerted by these radicles would depend on the extent to which they are still possessed of "residual affinity." If the hydrogen chloride, bromide, and iodide are present chiefly as simple molecules they should exert, *ab initio*, almost the full effect which they are capable of exerting; and the chief effect of dilution being to decompose the more complex molecules, conductivity should increase to but a slight extent if the extent to which simplification can take place be but small. On the other hand, if owing to the formation of molecular aggregates the residual affinity be more or less exhausted, the initial conductivity will be low, and it will increase on dilution only in proportion as these aggregates become broken up.

It appears to me that the behaviour of the four hydrides under discussion is absolutely in accordance with these requirements of the hypothesis. Even the difference between hydrogen chloride and hydrogen bromide and iodide is not without its bearing. The determinations of the density of chlorine at various temperatures by Ludwig, and of the density of bromine by Jahn (*Monatshefte für Chemie*, 1882, 176), have shown that it is necessary to raise the temperature considerably higher above the boiling-point in order to reduce the density to the theoretical value in the case of chlorine than in the case of bromine: in other words, there is a greater tendency in chlorine to form aggregates more complex than those of the formula Cl_2 than there is in bromine to form aggregates more complex than those of the formula Br_2. It is, therefore, not unlikely that the chlorine in HCl has more "residual affinity" than the bromine in HBr,* and if so the aqueous solution of the former would have a lower initial conductivity than one of equivalent strength of hydrogen bromide, and the maximum would be obtained only on greater dilution; which is precisely the case.

(To be continued).

* On other grounds also there is reason to believe that hydrogen chloride differs more from hydrogen bromide or iodide than either of these differs from the other: thus less heat is developed on dissolving hydrogen chloride in water than on dissolution of equivalent quantities of the bromide or iodide, the numbers given by Thomsen being—

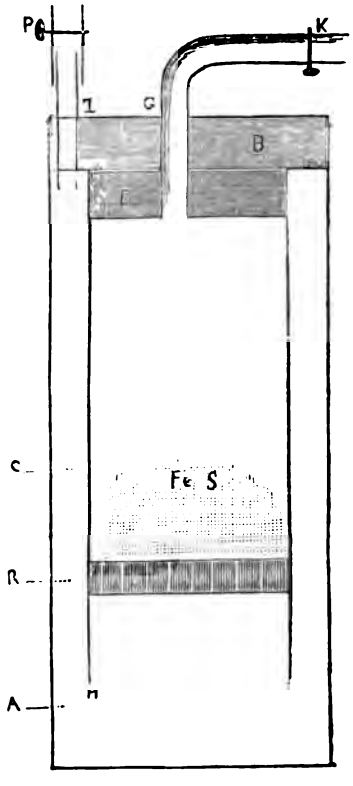
HCl, $400H_2O=17,300$ units.
HBr, $400H_2O=19,200$,,
HI, $400H_2O=19,200$,,

The solution of hydrogen chloride which distils unchanged at 112° at the ordinary pressure has approximately the composition represented by the formula $HCl.8H_2O$; whereas the corresponding solutions of hydrogen bromide and iodide boil at 125° and 127°, and their composition is approximately represented by the formulæ $HBr.5H_2O$ and $HI.5·5H_2O$. A solution of hydrogen fluoride, approximately of the composition $HF.2H_2O$, distils unchanged at 120°.

ON A NEW SULPHURETTED HYDROGEN GAS APPARATUS.

By JOHN J. BARLOW.

THE following is a drawing, with explanation in detail, of a sulphuretted hydrogen gas apparatus which I have been using now for some time, which works well, is simple and easy to make, and does not cost much, and I can by its means always have ready a supply of gas; nor does it give off any offensive odour.



A is a large jar, about 10 inches high and 3 inches in diameter; it is closed at the mouth with a very tight-fitting stopper, B, of indiarubber cut out of ¾-inch thick sheet-rubber, or, if this is not to be had, a good sound cork pushed in tight, about ½ inch below the top of the jar, and then well covered with wax or paraffin. Inside this jar, and fitting close up underneath the stopper B, is

a strong wide tube, about 8 inches long, and 2½ inches in diameter, C. The top end of this tube is also provided with a very tight-fitting stopper. A strong glass tube, G, ½ inch in diameter, passes through both of these two stoppers, one end just protruding about ⅛ inch below the inner stopper; the other end, outside and above the outer stopper, is bent round at right angles, and is connected with a piece of rubber tubing which is provided with a strong clip, K. This tube, G, serves for the exit of the gas, and also supports the inner jar, or tube C; R is a perforated cork, pushed up 1 inch inside the inner tube C; this cork supports the iron sulphide, FeS: *t* is a glass tube passing through the stopper of the outer jar, and is provided with a piece of rubber-tubing and clip, P.

To work the apparatus take out the inner tube, then place the FeS inside the inner jar, and resting on R; then place the tube C inside the jar A, pressing down the stopper B; open G by means of the clip K, remove the india-rubber-tubing from *t*, then insert a small funnel in the tube *t*, and pour in, and, filling the jar to within ½ an inch of the stopper B with dilute H_2SO_4 (1 : 6), remove the funnel; slip on the rubber-tube. Now open both clips, when the acid will rush up inside the inner vessel; close the tubes G and *t*; gas will now form, and will fill the tube C, and at last by its own pressure push out the acid liquid down as far as M, when the action will cease until a supply of gas is required, when the tube G will have to be opened and the liquid will again rush up into C, but will be pushed back again to M when the gas has reached a certain pressure in C.

Radcliffe Close Chemical Works,
Radcliffe, near Manchester, April 29, 1886.

CONTRIBUTIONS TO THE BACTERIOSCOPIC EXAMINATION OF WATER.

By Dr. LINK.

In a publication by Prof. Koch (*Med. Wochenschrift*, 1885, No. 37) on the scope of the bacteriological examination of water, it is asserted that "a large proportion of micro-organisms proves that the water has received putrescent admixtures, charged with micro-organisms, impure affluxes, &c., which may convey, along with many harmless micro-organisms, also pathogenous kinds, *i. e.*, infectious matters." Further, "As far as present observations extend the number of micro-organisms in good waters ranges from 10 to 150 germs capable of development per c.c. As soon as the number of germs decidedly exceeds this number the water may be suspected of having received affluents. If the number reaches or exceeds 1000 per c.c. such water should not be admitted for drinking, at least in time of a cholera epidemic."

The author has examined a great number of the Danzig well-waters chemically and bacterioscopically. The results obtained agree, however, very ill with the above opinions of Koch. On the contrary, it appears very plainly that regular relations between the chemical results and those of the bacterioscopic examination do not obtain. Many well-waters, chemically good and not directly or indirectly accessible to animal pollutions, often contained considerable numbers of microbia, whilst other waters, chemically bad and evidently contaminated by the influx of sewage, showed very small numbers of bacteria undergoing development. If we further consider that, by far the majority indeed, as a rule the totality of the bacteria contained in well-water, are indubitably of a harmless nature, and that when a pollution of the water by pathogenous germs has actually occurred, such germs will not in general find the conditions necessary for their increase, especially a temperature approximating to that of the body and a sufficient concentration of nutritive matter, but that they will rather perish from the overgrowth of the other bacteria inhabiting the water, we shall see that a judgment on the quality of water—according to the results of a bacterioscopic examination extending merely to a determination of the number of germs capable of development—must lead to inaccurate conclusions, which contradict the results of chemical analysis.

The attempt to put forward bacterioscopic examination as a decisive criterion for the character of a water is therefore devoid of a satisfactory basis. For the present the decision must be left to chemical analysis.—*Arch. Pharmacie* per *Chemiker Zeitung*.

CYCLAMOSE, A NEW SUGAR.

By GUSTAVE MICHAUD, D.Sc.

Cyclamose is found in the tubercles of *Cyclamen Europæum*. Its formula, as deduced from its analysis, is $C_{12}H_{22}O_{11}$. This formula is confirmed by the fact that cyclamose can be inverted by diluted acids. The most striking feature of cyclmose is its rotatory power (−15·15), which is left-handed, while all the other sugars in the group $C_{12}H_{22}O_{11}$ are right-handed or inactive. The activity of cyclamose is not affected by temperature, but it decreases under the influence of basic lead acetate. At 65° C. dilute hydric chloride almost immediately increases it, and makes it = −66·54 at 15° C., but this number rapidly decreases under the influence of heat. Like lactose, cyclamose reduces Fehling's solution.

Cyclamose is obtained by leaving for a few days tubercles of *Cyclamen* with weak alcohol (80 per cent). The filtered solution must be concentrated, and mixed with a great excess of strong alcohol (96 per cent), which determinates the formation of a precipitate of sugar. This precipitate is dissolved in water, and mixed with slaked lime. After filtration of the solution alcohol is added to it. The voluminous precipitate which appears is collected in a filter and washed with alcohol; then it is dissolved in water, and a current of carbonic dioxide is sent through it. The filtered solution, evaporated in an air-pump vacuum over a basin containing oil of vitriol, leaves pure cyclamose.

ON THE DETERMINATION OF ARSENIC.*

By LeROY W. McCAY.

(Continued from p. 222.)

The following are the *qualitative* tests made according to Holthof's directions, my object here being, as already intimated, to satisfy myself as to the exact degree of completeness of the reduction of the arsenic from the arsenic to the arsenious state of oxidation. In I., each of the 10 c.c. of H_2KAsO_4 solution taken were mixed in a flask with 50 c.c. sulphurous acid and 100 c.c. water, after which the flask and contents were heated for two hours upon the boiling water bath, then for two hours to incipient boiling upon a little sand-bath, whereupon the liquid was boiled down over a free flame to one-half the original volume; a large platinum spiral with pieces of pumice about the size of hazel nuts, threaded and twisted on each end, being introduced into the flask, partially to prevent bumping, partially to facilitate the disengagement of the sulphur-dioxide gas. In II., double the quantities of sulphurous acid and water used in I. were added; and in III., first the quantities used in I., second those used in II. In each case the liquid remaining after boiling down was emptied into a porcelain dish, evaporated to about 50 to 60 c.c., and tested for arsenic acid, (1) with silver nitrate, (2) with magnesia mixture, and (3) with magnesia mixture after removing the arsenic

* *American Chemical Journal* vol. vii., No. 6.

as the trisulphide with sulphuretted hydrogen in the cold, and displacing the latter with a rapid stream of carbon dioxide. The tests were made in strict accordance with the directions of Fresenius.* In no case was I able to obtain in the 50 to 60 c.c. a decided reaction for arsenic acid. For sake of convenience I arrange the experiments in outline as follows :—

I.

a. 10 c.c. solution, 50 c.c. SO_2 and 100 c.c. H_2O.
b. " " "
a. Reaction for As_2O_5 with $AgNO_3$, none. *b*. Reaction for As_2O_5 with magnesia mixture, none.

II.

a. 20 c.c. solution, 100 c.c. SO_2 and 200 c.c. H_2O.
b. " " "
a. Reaction for As_2O_5 with $AgNO_3$, none. *b*. Reaction for As_2O_5 with magnesia mixture, none.

III.

a. 10 c.c. solution, 50 c.c. SO_2 and 100 c.c. H_2O.
b. 20 c.c. solution, 100 c.c. SO_2 and 200 c.c. H_2O.
a. Reaction for As_2O_5 with magnesia mixture, after separation of As_2O_3, none. *b*. Reaction for As_2O_5 with magnesia mixture, after separation of As_2O_3, none.

These experiments go to prove that the reduction of the arsenic from the arsenic to arsenious state is to all intents and purposes complete, and in consequence thereof they confirm conclusively what Holthof has to say respecting the correctness of his mode of procedure. For quantitative work much experience has led me to believe that the following solutions are probably the most convenient :—

(*a*) $\frac{1}{10}$ *Normal Iodine Solution*.†—Dissolve 6·35 grms. of pure dry iodine with the help of about 10·0 grms. of potassium iodide in a little water, and dilute to a litre.

(*b*) $\frac{1}{10}$ *Normal Arsenious Oxide Solution*.† — Dissolve 2·475 grms. chemically pure arsenious oxide in a little warm potassium hydrate solution, neutralise with hydrochloric acid, and dilute to a litre.

Use for controlling the iodine solution :—

(*c*) *Starch Solution*.‡—Rub up thoroughly in a small porcelain mortar, with 10 c.c. of a solution of pure potassium hydrate of ordinary strength, 2 grms. of starch, and bring into 200 c.c. boiling water. Stir until solution is complete, cool, bottle, and preserve well corked. It will keep indefinitely.

(*d*) *Hydro-sodium Carbonate*.—Dissolve 150 to 200 grms. of the pure salt in 2 litres of water.

(*e*) *Sulphurous Acid*. — Use water *saturated* § with the gas.

Theoretically, 1 c.c. of the above $\frac{1}{10}$ normal iodine should exactly balance 1 c.c. of the $\frac{1}{10}$ normal arsenious oxide, and 1 c.c. = 0·001875 grm. As = 0·002475 grm. As_2O_3 = 0·002875 grm. As_2O_5 ; practically, however, 20 c.c. of the arsenious oxide solution required, in three separate trials, (1) 19·9, (2) 19·9, and (3) 19·9 c.c. of the iodine solution for complete oxidation. Hence 1 c.c. = 0·001884 grm. As = 0·002487 grm. As_2O_3 = 0·002889 grm. As_2O_5.

A. 1.—50 c.c. of the solution H_2KAsO_4, 100 c.c. SO_2, and 150 c.c. water were brought into a flask and heated for two hours upon a boiling water-bath, then for two hours upon a little sand-bath, and finally boiled down to one-half the original volume, a large platinum spiral being introduced into the flask to prevent bumping and facilitate the disengagement of the sulphur-dioxide gas. In all my experiments this boiling down to one-half the original volume (care being of course taken to introduce into the flask the platinum spiral) proved amply sufficient. I have not yet been able to detect any sulphur dioxide in a solution so treated. The solution was allowed to cool, diluted to 300 c.c., and for each of the first lot of estimations below given 30 c.c. for each of the second lot 60 c.c. taken. In titrating care was taken always to work under like conditions, the same quantities of hydro-sodium carbonate, starch, and water being invariably used. The most convenient volume of liquid for titration proved to be approximately 300 c.c. Accordingly, 30 c.c. reduced solution, 20 c.c. hydro-sodium carbonate, and 1 c.c. starch solution being diluted in a larger beaker to 300 c.c., the $\frac{1}{10}$ normal iodine solution was run in until a sky-blue colour resulted. The point of transition is remarkably easy to strike, and the reaction is so sharp and exact that one is never in doubt as to a single drop. The fact, too, that the blue appears shortly before the oxidation is complete, and a little extra stirring is necessary to cause it to disappear, furnishes us with an indication of the approach of the end of the operation, and thereby renders it almost impossible for one to overstep the point.

Four estimations :—

No.	Red Solut'n.	1·40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	30 c.c.	15·7 c.c.	0·0295 grm.	0·0390 grm.	0·0453 grm.
2	30	15·7	0·0295	0·0390	0·0453
3	30	15·7	0·0295	0·0390	0·0453
4	30	15·75	0·0296	0·0391	0·0454

Actually present :—

As = 0·0296 = 0·0390, As_2O_3 = 0·0453 As_2O_5.

Three estimations :—

No.	Red Solut'n.	1·40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	60 c.c.	31·5 c.c.	0·0593 grm.	0·0783 grm.	0·0910 grm.
2	60	31·5	0·0593	0·0783	0·0910
3	60	31·6	0·0595	0·0785	0·0915

Actually present :—

As = 0·0593 grm. = 0·0782 grm. As_2O_3 = 0·0907 grm. As_2O_5

2.—100 c.c. H_2KAsO_4, 150 c.c. SO_2 solution, and 200 c.c. water were brought into a flask and reduced as above described. After boiling the liquid down to one-half the original volume, cooling and diluting to 1000 c.c., the following results were obtained. For each determination 100 c.c. solution were taken :—

No.	Red Solut'n.	1·40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	100 c.c.	31·7 c.c.	0·0597 grm.	0·0788 grm.	0·0916 grm.
2	100	31·8	0·0599	0·0791	0·0918
3	100	31·7	0·0597	0·0788	0·0916
4	100	31·8	0·0599	0·0991	0·0918

Fifty c.c. of same solution required 15·9 c.c. $\frac{1}{10}$ normal iodine = 0·02995 As = 0·0395 As_2O_3 = 0·0459 As_2O_5.

The average number of c.c. of $\frac{1}{10}$ normal iodine used in this lot of tests is 31·75 ; the average number used in the lot immediately preceding is 31·53 ; the difference between the two is 0·22 c.c. This 0·22 is a distinct plus, and requires explanation in spite of the fact that owing to the extremely dilute iodine solution it is too small to occasion any decidedly appreciable error in the results. The excess is, I am inclined to believe, probably due to the action on the iodine of organic matter in the distilled water, the destructive capacity of this matter as regards iodine increasing, as a matter of course, with the increase in the quantity of water used, as well as with the length of time requisite for reducing and boiling down to the required volume. It will be observed that in the second experiment more water was used than in the first, and in consequence thereof that the time necessary for reducing and boiling down is greater in the latter than in the former case.

B. 1.—To test the method further I brought 2·475 grms. As_2O_3 into a litre-flask with a long narrow neck, added 100 c.c. pure nitric acid, and, having clamped the flask in an inclined position in the water-bath, heated the contents to boiling. As soon as all reaction had ceased the flask

* Fresenius, *Anleitung zur Qualit. Chem. Analyse*, 14 Aufl., cxcix., 9.
† Modern system. See Clemens Winkler's *Maasanalyse*, Freiberg, 1883.
‡ Alex. Muller, *Landw. Versuchs-Stationen*, xxvii., 340. See also

gently over a free flame until all hyponitric oxide fumes had disappeared and the solution was clear and colourless; 20 c.c. dilute sulphuric acid were then added, the solution was transferred to a porcelain dish, evaporated down until every trace of nitric acid was expelled, cooled, neutralised, and diluted to a litre: 50 c.c. of this solution were mixed with 150 c.c. SO_2 solution, 200 c.c. water added, and the whole was treated as already described—for two hours on the water-bath, two hours on the sand-bath, and finally boiled down over a free flame to a little less than one-half the original volume. The liquid after cooling was diluted to exactly 200 c.c., and for each of the following tests 50 c.c. taken:—

No.	Red Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	50 c.c.	12·5 c.c.	0·0235 grm.	0·0311 grm.	0·0361 grm.
2	50	12·5	0·0235	0·0311	0·0361
3	50	12·5	0·0235	0·0311	0·0361
4	50	12·5	0·0237	0·0313	0·0363

Since 1000 c.c. standard solution = 2·475 grms. As_2O_3, 50 c.c. = 0·12375 grm. As_2O_3; and since the 50 c.c. were after reduction and boiling down diluted to 200 c.c., 50 c.c. or ¼ of 200 c.c. = 0·0309 grm. As_2O_3, a figure which agrees very well with that found by analysis.

2.—100 c.c. standard solution, 200 c.c. SO_2 solution, and 200 c.c. water were reduced, boiled down, cooled, and diluted to 500 c.c. Four tests were made, each with 100 c.c.:—

No.	Red Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	100 c.c.	20·1 c.c.	0·0378 grm.	0·0499 grm.	0·058 grm.
2	100	20·1	0·0378	0·0499	0·058
3	100	20·05	0·0377	0·0498	0·058
4	100	20·1	0·0378	0·0499	0·058

Theory demands—

0·0375 As = 0·0495 As_2O_3 = 0·0575 As_2O_5.

Twenty c.c. of the standard solution should require, after reduction, 19·9 c.c. $\frac{1}{40}$ normal iodine, whereas, as will be seen, 20·1 c.c. were used. The cause of the error, 0·22 c.c., has already been suggested. The error is so small that it in no case materially affects the accuracy of the results.

Having had occasion during my examination of the Holthof method to subject several organic compounds, at high temperatures and under pressure, to the oxidising influence of certain reagents, the thought suggested itself that, perhaps, by acting on arsenic acid with sulphurous acid under pressure, the reduction of the former to the lower stage of oxidation might be easily accomplished, and that too in a comparatively short period of time. The results of some qualitative experiments in this direction will be found in the Chemical News, vol. li., No. 1320, March 13th, 1885. The results obtained were very satisfactory, and seemed to prove without a doubt that when arsenic acid, sulphurous acid, and water are heated for one hour in hermetically closed flasks, and at a temperature equal to that of boiling water, the arsenic acid is completely reduced to arsenious acid. In my article in the Chemical News I have given the results of seven experiments, the quantity of arsenic as arsenic acid in each test ranging from 0·06 to 0·90 grm. In every case excepting one the reduction was complete. In the last experiment (0·9 grm. arsenic acid present) 20 c.c. of the reduced solution gave with magnesia mixture, after boiling off the sulphur dioxide, a slight reaction for arsenic acid—one so slight, however, that upon filtering off the precipitate and dissolving it in a drop of nitric acid, no reddish brown colour or precipitate was obtained with silver nitrate and ammonia. In all the seven experiments my tests were made upon *portions* of the reduced solution; consequently it seemed well, before trying the process quantitatively, again to make a series of experiments, using the entire quantity of the reduced liquid for a test, exactly as was done in my examination of the Holthof method of reduction.

I proceeded as follows:—

The solution of H_2KAsO_4 was brought into a little bottle provided with a well-fitting ground-glass stopper, and capable of withstanding a pressure corresponding to the heat of a boiling water-bath, a strong solution of sulphurous acid run in, the bottle tightly stoppered, and the stopper firmly tied down with a piece of cord. The bottle was next placed in a water-bath, the contents of which had been brought to active boiling, and here permitted to remain for exactly one hour. After cooling, the reduced liquid was emptied into a flask, diluted to about 150 c.c., and boiled down to one-half the volume, care being taken to introduce into the flask a large platinum spiral. It was then transferred to a porcelain dish, evaporated to 50 c c., filtered, and tested for arsenic acid—(1) with silver nitrate, and (2) with magnesia mixture.* Six tests were made, but in no case could I, after boiling down, obtain in the 50 c.c. a definite reaction for arsenic acid.

I.

10 c.c. H_2KAsO_4 solution;
20 c.c. SO_2 solution.

10 c.c. = 0·0593 grm. As = 0·0782 grm. As_2O_3 = 0·090 grm. As_2O_5.

Reaction for As_2O_5 with silver nitrate, none.

II.

10 c.c. H_2KAsO_4 solution;
20 c.c. SO_2 solution.

10 c.c. = 0·0593 grm. As = 0·0772 grm. As_2O_3 = 0·090 grm. As_2O_5.

Reaction for As_2O_5 with magnesia mixture, none.

III.

20 c.c. H_2KAsO_4 solution;
30 c.c. SO_2 solution.

20 c.c. = 0·1186 grm. As = 0·1564 grm. As_2O_3 = 0·180 grm. As_2O_5.

Reaction for As_2O_5 with silver nitrate, none.

IV.

20 c.c. H_2KAsO_4 solution;
30 c.c. SO_2 solution.

20 c.c. = 0·1186 grm. As = 0·1564 grm. As_2O_3 = 0·180 grm. As_2O_5.

Reaction for As_2O_5 with magnesia mixture, none.

V.

30 c.c. H_2KAsO_4 solution;
40 c.c. SO_2 solution.

30 c.c. = 0·1779 grm. As = 0·2346 grm. As_2O_3 = 0·270 grm. As_2O_5.

Reaction for As_2O_5 with silver nitrate, none.

VI.

30 c.c. H_2KAsO_4 solution;
40 c.c. SO_2 solution.

30 c.c. = 0·1779 grm. As = 0·2346 grm. As_2O_3 = 0·270 grm. As_2O_5.

Reaction for As_2O_5 with magnesia mixture, none.

(To be continued.)

A METHOD OF FILTRATION BY MEANS OF EASILY SOLUBLE AND EASILY VOLATILE FILTERS.

By F. A. GOOCH.

The processes of analysis, in which it is desirable to redissolve precipitates from the filter after washing, or to separate a mixed precipitate into parts by the action of appropriate solvents, are many.

* The solutions stood 12 to 24 hours.

When a complete solution is the object, and the precipitate yields easily to solvents which do not affect paper injuriously, the use of the ordinary filter offers no difficulty. When, however, precipitates are to be treated with reagents which disintegrate paper-filters, the case is otherwise; and the attempt to remove, by solvents, any individual part of a mixed heterogeneous mass upon a filter is always an uncertain matter, As examples of cases of this sort, difficult to deal with, we may take the solution of acid sodic titanate in strong hydrochloric acid; or the purification of baric sulphate from included salts by digestion in strong hydrochloric acid; or the separation of sulphides which are soluble from those which are insoluble in alkaline sulphides; or the washing out of free sulphur from precipitated sulphides by means of carbon disulphide; or the separation of calcic and baric sulphates by the action of sodium hyposulphite. In cases of this nature it is often convenient to make use of the asbestos filter which I have previously described;* but this sometimes has its disadvantages. Thus, to recur to the examples just cited, acid sodium titanate may be filtered and washed upon an asbestos filter, and felt and precipitate treated together with hydrochloric acid, but it will be impossible to determine when solution is effected, because of the floating asbestos; and in separating the sulphides it would be necessary to know the weight of the asbestos felt, since it must be weighed finally with the insoluble sulphides, unless removed by a special treatment which involves the solution, filtration, and re-precipitation of the latter.

It is to meet cases like these that I have sought a filter which, in the reversal of the ordinary mode of separating filter and precipitate, should dissolve easily in solvents which do not affect the ordinary precipitates met with in analysis. The material which seems best suited to the case—light and fluffy, capable of making secure filters of any desirable degree of porosity, sufficiently insoluble in water and aqueous solution of salts, alkalies, and acids (excepting strong sulphuric, strong nitric, and glacial acetic acids), easily soluble in naphtha, benzol, carbon disulphide, ether, boiling alcohol, and essential oils, and not too costly—is anthracene.

The mode of preparing and using the filter is simple. Anthracene is slightly moistened with alcohol to make it miscible with water, diluted to the right consistency, and applied to the same apparatus, and in the same way as the emulsion of asbestos which is employed in making asbestos felts; that is to say, enough of the emulsion in water to form a layer of the proper thickness is poured into a perforated crucible, which is held tightly in a packing of rubber-tubing stretched over a funnel fitted in the usual manner to a vacuum-flask or receiver. After washing with water the filter is ready for use. If the felt happens to be too coarse for the use of the moment, it may be made as close as need be by coating the felt first deposited with a finer emulsion, made by dissolving anthracene in hot alcohol and precipitating with water. When voluminous precipitates are to be filtered, the large perforated cone, described in the former paper, to which I have referred, may be substituted with advantage for the crucible; or Cooke's improved form† of Carmichael's process of reverse filtration may prove most useful. In using the cone it is well to apply the anthracene in a thick layer.

To remove the anthracene filter from a precipitate it is only necessary to act with the proper solvent. It is usually convenient to stand the crucible containing precipitate and felt in a small beaker, add enough of the solvent, and gently warm until the anthracene dissolves. On the addition of water, or the reagent to work upon the precipitate, the solution of anthracene floats, and nothing remains to obstruct or obscure the action. If the precipitate dissolves entirely, the solution of anthracene may be separated from the aqueous solution by simply pouring the fluid upon a filter previously moistened with water, when the solution in water runs through, and the anthracene and its solvent remain and may be washed indefinitely with water.

If, on the other hand, the case is one of the division of precipitates, the anthracene and its solvent may be made to pass the filter, after the water has run through, by adding a little alcohol to overcome the repulsion between the solution and the water which fills the pores of the filter, the precipitate which stays behind being washed first with a solvent of anthracene, and then, if necessary, with alcohol followed by water; or, if the vacuum filter be used (either paper or asbestos, according to the circumstances of the case), both liquids leave the precipitate and traverse the filter together.

In general I prefer benzol as the solvent for anthracene, but some advantage may be gained in special cases by a proper choice of solvents. Thus, in removing intermixed sulphur from precipitated sulphides, both the anthracene and the sulphur may be dissolved in carbon disulphide in a single operation.

The ready volatility of anthracene, at a temperature very near its melting-point, 213° C., makes it easily separable in cases when to remove it by a solvent is not advisable. The treatment of a solution of anthracene, for example, with strong sulphuric or nitric acid is apt to produce carbonaceous or gummy residues. In such cases it is well either to heat precipitate and filter directly, or to first remove them from the crucible by means of a solvent for anthracene, then evaporate this, and raise the heat gently until the anthracene has vanished. The purification of precipitated baric sulphate, by dissolving it in hot, strong sulphuric acid, and re-precipitating by dilution, is a case in point, and one, too, in which the reversed filter may be used with great advantage. It may be remarked, in passing, that if one does not happen to possess a platinum rose, and does happen to have at disposal a perforated crucible, a very fair reversed filter may be improvised of the crucible, a piece of glass tubing, and a rubber stopper, the last being fitted to the crucible, and the tube passed through nearly to the perforated bottom.

At every point in the preparation and use of the anthracene filter I have found the manipulation peculiarly easy.—*American Chemical Journal.*

* *American Chemical Journal*, i., 237.
† *Proceedings of the American Academy*, xii., 124.

A NEW METHOD FOR THE DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.*

By J. B. MACKINTOSH, School of Mines, New York.

(Concluded from p. 225.)

THESE two last experiments showed that oxygen was not sufficient to convert the phosphorus in the forms lost into phosphoric acid; so the problem resolved itself into finding a method of converting the lower oxygen compounds of phosphorus into phosphoric acid without simultaneously oxidising ferrous to ferric iron. The solution of this problem was obtained in the next trial. The process is the same as before described, using hydrochloric acid as the solvent, and a current of oxygen;† and after raising the solution to boiling, introducing an excess of a strong solution of sulphurous acid previously placed in the flask A, and continuing the boiling for some minutes. The result of the reaction is visible in the precipitation of sulphur in the solution, and the insoluble residue is much altered in appearance, being much more disintegrated. The results obtained in this experiment were: total phos.

* From the *Transactions of the American Institute of Mining Engineers.*

† The use of oxygen in place of hydrogen is recommended because it has no appreciable oxidising effect on the iron solution, while it prevents the reduction of the permanganate, which rapidly takes place with hydrogen.

No.	Sample.	P.c. P.	Method employed.	Per cent P found. Residue.	Solution.	Gas.	Total p.c. found.	Loss.	Per cent distribution. Residue.	Solution.	Gas.	Loss
1	Bar-iron..	0·124	Sol. in HCl and direct basic acetate precipitation.		0·122	—	0·122	0·002	—	98·4	—	1·6
2	Pig	0·826	Sol. in HCl and direct basic acetate precipitation.		0·580	—	0·580	2·46	—	—	—	—
3	Iron phosphide ..	6·50?	Sol. in HCl in H atmosphere. Gas absorbed in $K_2Mn_2O_8$ and HNO_3	3·79	2·16	0·05	6·00	0·50	58·31	33·23	0·77	7·69
4	Pig	0·880	Sol. in HCl in H atmosphere. Gas in $K_2Mn_2O_8 + H_2SO_4$.	0·345	0·451	0·019	0·815	0·065	39·11	51·13	2·16	7·60
5	Pig	1·48	Sol. in HCl in O atmosphere. Gas in $K_2Mn_2O_8 + HNO_3$	—	—	—	1·42	0·06	37·47	55·20	3·28	4·05
6	Pig	0·880	Sol. in HCl in O atmos. Mixed all portions. Gas in $K_2Mn_2O_8 + H_2SO_4$.	—	—	—	0·771	0·109	—	87·41	—	12·59
7	Pig	0·880	H_2SO_4 in O atmosphere and solution boiled 15 minutes.	—	—	—	0·767	0·111	14·17	70·86	1·81	13·16
8	Pig	0·880	HCl in O atmosphere boiled with excess SO_2.	—	—	—	0·882	Gain. 0·002	13·49	80·84	5·67	0·00
9	Pig	0·880	HCl in O atmosphere boiled with excess SO_2, but all portions mixed.	—	—	—	0·865	0·015	Slight loss in course of analysis.			

phorus present, 0·882 per cent, weighed as magnesia pyrophosphate (care being taken to ensure its purity by re-solution and re-precipitation of the magnesia precipitate) distributed—

In residue	13·49 per cent.
In solution	80·84 ,,
In gas	5·67 ,,
	100·00 ,,
Loss	0·00 ,,

In confirmation of this result I made another determination in the same manner, starting at noon; by the following morning I found 0·865 per cent of phosphorus, and had lost a small amount in the course of the rather hurried analysis.

The results obtained are given above in tabular form.

I also made some confirmatory experiments on the sample used in experiment No. 5, weighing the yellow precipitate first obtained, instead of purifying it by re-precipitation. The precipitates carried traces of iron, which in experiments 11 and 12 entered into the magnesia precipitates. This explains discrepancies observable between the results calculated from the weights of the yellow precipitate and from those of the magnesic pyrophosphate.

Percentage P.	Old method. No. 5.	New Method. No. 10.	No. 11.	No. 12.
Weighed as yellow precipitate	1·447	1·49	1·451	1·463
No. of precipitations	2	1	1	1
Weighed as $Mg_2P_2O_7$	1·480	1·456	1·516	1·539
No. of precipitations	1	2	2	1

From inspection of this table it is seen that there is a far closer agreement between the results calculated from the weights of the yellow precipitate than in those calculated from the magnesic pyrophosphate; and I am of the opinion that the true percentage of this sample is very near 1·454, the average of the four lowest results obtained.

In experiment 10 the phosphorus found was distributed—

In residue	23·10
In solution	73·00
In gas	3·90
	100·00

In experiments 11 and 12 all portions were mixed together.

The following is a brief outline of the steps to be followed:—

1. Solution in hydrochloric acid in a stream of oxygen or air, absorbing the escaping gases in permanganate acidified with sulphuric acid.

2. Heating the solution to boiling, stopping the passage of the oxygen current, and carefully adding an excess of sulphurous acid solution, and continuing the boiling till the precipitated MnO_2 in the absorption-flask is redissolved. This boiling should last several minutes to ensure the completion of the reaction.

3. Disconnecting the junctions between the absorption-flasks and solution-flask, and between the solution-flask and the acid-flask, and allowing to cool.

4. Mixing solutions, filtering out residue which is placed (with filter-paper) in a porcelain casserole, oxidising with nitric acid and potassium chlorate, and evaporating to dryness.*

5. Boiling the solution till the excess of sulphurous acid is expelled, adding a few c.c. of permanganate to peroxidise a little of the iron, and precipitating basic acetates. Boiling the filtrate for other precipitates, to ensure getting all the phosphoric acid present.

6. Dissolving these precipitates in hydrochloric acid and adding to the solution of the residue in which, by this time, the paper will have been thoroughly destroyed.

7. Evaporating to dryness for silica, and proceeding as usual with the molybdate precipitation.

The saving of time by this process is the greater as the percentage to be determined is less. In a steel of low percentage, where it is necessary to use 10 grms. for the determination, necessitating the use of 120 c.c. of nitric acid for solution, by the old method, the time taken for the evaporation of this amount of liquid, for the subsequent thorough drying of the residue, and for the resolution and reduction of the iron to the ferrous state, is evidently much greater, and the operations followed are much more

* I prefer to filter out the residue instead of filtering it out with the first basic acetate precipitate, because it is difficult to work accurately on a muddy liquid, and because there is a probability of loss of phosphorus by the continued action of the hot acid solution on the residue, after the sulphurous acid has been expelled. By proceeding as directed this chance of loss is removed. Perhaps some of the loss in the ninth experiment may be due to this cause, as the residue in that ex-

tedious than by this method, where the phosphorus is concentrated at the start in but a few milligrms. of iron in very little bulk of solution, enabling the subsequent evaporation to dryness and thorough drying of the residue to be performed in a very short period.

In M. Tantin's experiments he used cast-iron only. Mine have been conducted on pig- and wrought-iron. It is possible that the difference in our results may be partially accounted for by different modes of occurrence of phosphorus similar to the different forms of carbon, but of this I cannot speak from experience, and merely offer it as a suggestion.

The small amount of phosphuretted hydrogen which is found seems to be the product of a secondary reaction between phosphorous acid and the nascent hydrogen evolved. Whether hypophosphorous or hypophosphoric acids are present, or, indeed, whether phosphorous acid is present, I am at present unable to say, but the results obtained point to the presence in the solution, along with phosphoric acid, of one or more of these, as the cause of loss. The use of sulphurous acid, however, oxidises these to phosphoric acid without affecting the iron, so that by this process a determination can be made in a day which formerly required several days.

In calculating the percentage of phosphorus from the weight of the yellow precipitate I have used in all cases the figure of 1·63 per cent phosphorus in the precipitate, and have thought it worth while to give the results I have obtained in two determinations I have recently finished. I prepared the yellow precipitate from phosphoric acid, precipitated in the usual manner with excess of molybdic acid. One of these precipitates (A) was purified from possible excess of molybdic acid by solution and re-precipitation; the other (B) was analysed without going through this process. The magnesia precipitate obtained from A was also purified by solution and re-precipitation, while that from B was ignited and weighed direct. The results are given below.

	A.	B.
Weight of yellow precipitate dried at 95° to 100° C.	1·2802	1·1428
Weight of $Mg_2P_2O_7$	0·0735	0·0664
Weight of P calculated from $Mg_2P_2O_7$	0·02053	0·01854
Percentage of P in yellow precipitate..	1·603	1·623
Weight of P calculated from yellow precipitate, assuming factor 1·63 per cent..	0·02087	0·01863

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 6th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

The following were formally admitted Fellows of the Society:—Messrs. John W. King, William Herbert Hyatt, and George T. Holloway.

Certificates were read for the first time in favour of Messrs. James Blake, M.D., F.R.C.S., 1, Sussex Gardens, W.; Forbes Rickard, Ashcombe, Carlton Road, Putney; Charles A. R. Jowitt, Scotia Works, Sheffield.

The following papers were read:—

44. "*Paranitrobenzoylacetic Acid and some of its Derivatives.*" By Dr. W. H. Perkin, Jun., and Dr. E. Bellinot.

On account of the difficulty of producing ethylic benzoylacetate free from acetophenone, benzoic acid, and other impurities, unsatisfactory results were obtained on attempting to prepare the nitro-derivative directly from it; the authors have therefore prepared *paranitrobenzoylacetic acid*, $NO_2{\cdot}C_6H_4{\cdot}CO{\cdot}CH_2{\cdot}COOH$, from paranitrophenylpropiolic acid obtained by combining ethylic paranitrocinnamate with bromine and treating the resulting ethylic paranitrophenyldibromo propionate with alcoholic potash. The conversion of paranitrophenylpropiolic acid into paranitrobenzoylacetic acid is effected by dissolving the former (50 grms.) in 80 to 85 per cent sulphuric acid (2 to 3 kilos.), and maintaining the liquid at 35° to 40° for fifteen hours. The pure acid crystallises from benzene in microscopic needles; it melts at 135°, being resolved into paranitracetophenone and carbon dioxide, a decomposition which also takes place on boiling it with water. Owing to their instability, the preparation of its metallic salts is a matter of some difficulty. *Methylic paranitrobenzoylacetate* crystallises from alcohol in monoclinic prisms, melting at 106° to 107°; on treatment with sodium methylate or ethylate, it yields a monosodium derivative of remarkable stability. On heating this compound with benzyl chloride and a little alcohol in sealed tubes at 150°, it is converted into *methylic paranitrobenzoylbenzylacetate*, a body which crystallises from dilute alcohol in colourless plates, melting at 57°. *Ethylic paranitrobenzoylacetate* crystallises from a mixture of benzene and light petroleum in monoclinic prisms—of which, as well as of the methylic salt, measurements by Prof. Haushofer are given in the paper—melting at 75°; it dissolves fairly easily in sodic hydrate solution, being re-precipitated unchanged on the addition of acids. The sodium derivative may be obtained in a pure state by means of sodium ethylate: it crystallises from boiling alcohol in small orange-yellow needles, and may even be re-crystallised from water; from it other metallic derivatives may readily be prepared.

Ethylic paranitrobenzoylethacetate, prepared by the action of ethyl iodide on the sodacetate, crystallises from dilute alcohol in colourless plates, melting at 39° to 40°; the corresponding *allylacetate*, prepared by the action of allyl iodide, melts at 45° to 46°. All attempts to prepare the acids from these salts by hydrolysis were unsuccessful.

Ethylic diparanitrobenzoylsuccinate,—

$$(C_6H_4{\cdot}NO_2)_2C_2H_2{\cdot}(COOEt)_2,$$

obtained by treating ethylic paranitrobenzoylsodacetate with iodine, crystallises from dilute alcohol in colourless needles melting at 180°. By the action of nitrous gas on an ethereal solution of ethylic paranitrobenzoylacetate, the *isonitroso*-derivative is obtained; it crystallises from dilute alcohol in colourless needles melting at 220°.

45. "*An Acetic Ferment which forms Cellulose.*" By Adrian J. Brown.

The acetic ferment described in this paper is well known as the "vinegar plant" or "mother." Pure cultivations of it were made by a combination of the "fractional" and "dilution" methods, and also by growing it in a solid gelatin medium. The mode of growth of the tough gelatinous membrane of the ferment is described, its general appearance being very similar to a soft animal membrane. The membranous growth of the "vinegar plant" is the only form which it assumes, no matter how the conditions are varied. *Bacterium aceti* never assumes this form; moreover the "vinegar plant" gives all the chemical reactions of cellulose, but are not yielded by any form of *B. aceti*: the two ferments are therefore specifically distinct. The morphology of the ferment is described, and also its fermentive actions. The latter, so far as examined, are similar to those of *B. aceti* (comp. *Trans.*, 1886, 172), viz., ethylic alcohol is oxidised to acetic acid, and the acid so formed is afterwards decomposed. Dextrose yields gluconic acid, and mannitol is converted into lævulose. Like *B. aceti* also, it had no fermentive action on cane-sugar or lævulose.

Treatment of a membrane of the "vinegar plant" by H. Müller's bromine method leaves a film of pure cellulose of the same shape and character as the original membrane. The reactions of this cellulose are given, showing it to be ordinary cellulose like that from cotton-wool.

The formation and use of cellulose by a simple cell plant is of interest in connection with the important part this body plays in the more highly organised plants. Experiments were therefore made to determine from what bodies the "vinegar plant" forms its cellulose. Cane-sugar, starch, and ethylic alcohol are not converted into this body; dextrose, however, can be so converted. In this latter case, therefore, the cells of the ferment have a double action upon the sugar, viz., the production of gluconic acid and the building up of cellulose. The latter action, however, cannot be considered one of fermentation.

Mannitol and lævulose are converted into cellulose, and favour the growth of the ferment more strongly than dextrose.

The usual method of preparing "home made" vinegar by means of the "vinegar plant," is to introduce a membrane into a solution of cane-sugar. The pure ferment has no action on this sugar, but the ordinary impure ferment used contains yeast cells, and these invert and ferment the sugar, so preparing alcohol for conversion into vinegar by the acetic ferment.

The name *Bacterium xylinum* is suggested for the "vinegar plant."

Discussion.

Mr. Warington after noticing the remarkable formation of cellulose from lævulose, said that it would be important to ascertain, if possible, at what stage oxidation sets in. Recent experiments by Müntz clearly show that organisms may promote oxidations which cannot be of service to the life of the organism, and which, therefore, must be regarded as unessential thereto.

The President said that it had hitherto been always supposed that cellulose was the very foundation of all vegetable cells, and it was therefore particularly interesting to have it established that certain bacteria did not contain cellulose.

At the next meeting, on May 20th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Action of Aldehydes and Ammonia on Benzil" (continued). By Francis R. Japp, F.R.S., and W. Palmer Wynne, B.Sc.

"Imabenzil." By the same.

"Ammonia-derivatives of Benzoïn." By F. R. Japp and W. H. Wilson, Ph.D.

"Compounds of Benzil and Benzoïn with Alcohols." By F. R. Japp and Julius Raschen.

"The Action of Phosphoric Sulphide on Benzophenone." By the same.

"The Preparation and Saponification of Hydrocyanides of the Diketones." By F. R. Japp and N. H. J. Miller, Ph.D.

PHYSICAL SOCIETY.

May 8th, 1886.

Prof. H. McLeod, F.R.S., Vice-President, in the Chair.

Mr. W. A. Price was elected a Member of the Society.

The following communications were read:—

"*On a Modified Form of Wheatstone's Rheostat.*" By Shelford Bidwell.

A wire is coiled upon a non-conducting cylinder, as in the ordinary forms of rheostat, one end of the wire being in contact with the brass axle of the cylinder. A screw is cut upon the axle, the pitch being equal to the distance between the consecutive turns of the wire, and this, working in a fixed nut, causes the whole cylinder to travel in the direction of its axis. A fixed spring bears upon the wire at a convenient point, and by the travelling motion of the cylinder this point of contact remains fixed in space, and the effect of turning the cylinder is to introduce more or less resistance between the spring and the brass axle. Binding screws on the base of the instrument are in contact with the nut and the bearing spring. Though this arrangement has several obvious advantages over the usual forms, Mr. Bidwell does not recommend it in cases where it is required to introduce a known resistance, but where it is important to adjust a resistance to a nicety or to cause a continuous variation it is of great use.

Prof. Perry, remarking upon the importance of being able to vary a resistance gradually, described an instrument he had used with advantage. A number of plates of gas-carbon are placed between two parallel copper plates, one of which is fixed and the other adjustable by a screw: by applying pressure by means of the screw the resistance between the plates can be varied uniformly and regularly from 2 to 10 ohms, beyond which point the increase is very rapid.

"*On a Theorem relating to Curved Diffraction Gratings.*' By Walter Baily.

In a paper read before the Society in January, 1883, the author showed that if a plane be taken perpendicular to the lines of a curved diffraction grating and a normal to the grating be taken as the initial line, then the equation—

$$\frac{\mathrm{Cos}^2\,\theta}{r} = \frac{\mathrm{Cos}\,\theta}{c} + \frac{1}{d},$$

in which c is the radius of curvature of the grating and d is an arbitrrary constant, gives a curve having the property that if a point of light be placed anywhere upon it, the curve is the locus of the foci of all diffracted rays, whether reflected or transmitted. In the present investigation d is supposed to be greater than c, which allows of the source of light being at infinity. The points where the curve given by the above equation cuts the normal are called the normal foci. There are two of these, one relating to the reflected and the other to the transmitted light, the grating being supposed to consist of a number of opaque lines in space. It is then shown that if the grating be supposed to turn about the line in it intersecting the initial line, the normal foci will trace out two parabolas whose common focus is the origin, and common *latus rectum* is equal to the diameter of curvature of the grating, the parabola for reflected light being convex to the source of light, and that for transmitted light concave.

"*On some Thermo-dynamical Relations.*" Part IV. By Prof. W. Ramsay and Dr. Sydney Young.

The first part of this communication deals with Profs. Ayrton and Perry's criticisms upon the previous papers by the authors upon this subject. In the second part a brief review is given of the various attempts that have been made to represent the pressure of a saturated vapour as a function of the temperature.

Molecular Weight of Liquid Water.—Thomsen has called attention to the fact that the conclusion reached by Raoult in his researches on the freezing-point of saline solutions, that water possesses, in the condition of liquid, twice the molecular weight which it has in the condition of vapour, coincides with the conclusion to which he himself had come from his investigations on the constitution of hydrated salts. In his thermo-chemical researches Thomsen says: "A glance at the table of heat of hydration of hydrated salts shows that the water molecules enter often in pairs with the same heat-change; a fact explicable either by supposing that the molecules of water are symmetrically placed in the molecule of the salt, or, and perhaps more probably, that the molecular weight of liquid water is twice that of water vapour. The similarity of these conclusions, from widely different fields of investigation, is noteworthy.—*Ber. Berl. Chem. Ges.*

NOTICES OF BOOKS.

A Pocket-Book for Chemists, Chemical Manufacturers, Metallurgists, Dyers, Distillers, Brewers, Sugar Refiners, Photographers, Students, &c. By THOMAS BAYLEY, Analytical and Consulting Chemist and Assayer. Fourth Edition. London and New York: E. and F. N. Spon.

WE have here the issue of this useful laboratory-companion for the present year. The work treats in succession of atomic weights and factors, useful data, chemical calculations, rules for indirect analysis, weights and measures, thermometers and barometers, chemical physics, boiling-points, solubilities, specific gravities, instructions for analysis, mineralogy, assaying, alcohol, beer, sugar, and miscellaneous technical matter. There is also an appendix.

We find two tables of atomic weights, the second of which gives the latest determinations. In the first table gold and platinum rank both = 196·7. In the second gold is given = 196·2, whilst platinum retains the figure 196·7. But in the most recent determinations with which we are acquainted, *i.e.* those of Seubert, verified by Halberstadt, Pt = 194·576, a result more in conformity with what theory requires.

In the paragraph on alkalimetric indicators we find mention only of litmus, cochineal, and turmeric. This seems an oversight, since certain indicators which have recently come into use are preferable under a variety of circumstances.

Perhaps doubts may be raised concerning the fairness of the distribution of space. Alcohol, beer, and sugar—the last a moribund, if not a dead industry as far as Britain is concerned—these three subjects occupy 71 pages, whilst to all other departments of technical chemistry only 20 pages are allotted.

The tables for the use of that fallacious instrument, Quevenne's lacto-densimeter, might have safely been omitted.

The table showing the periodic classification of the elements bears a very judicious and equitable heading. It is entitled: "The elements arranged by Mendelejeff according to Newland's periodic classification."

As a whole this pocket-book must, as in former years, continue to be regarded as an invaluable vade mecum both for the laboratory and in chemical works.

CORRESPONDENCE.

PATENTS FOR ANALYTICAL PROCESSES.

To the Editor of the Chemical News.

SIR,—In thanking you for your recent notice of three of my small Manuals I hope you will allow me to make brief statements relating to an Appendix and to the question of Patents—both of which subjects were mentioned in your notice.

My Manuals appeal to a wide public; the "Water Analysis," for instance, has had nearly 7000 readers since it first appeared in the year 1868. Not only is the audience wide, but it is select, being, to a great extent, a student audience. Under these circumstances I am quite alive to the responsibilities laid upon me.

The Appendix of the "Water Analysis" is designed to place before the student the history of the development of modern water-analysis, and accordingly in the Appendix I have reproduced some of the original papers in the form in which they were communicated to scientific journals, and a short account of the violent controversies which have raged round the ammonia-process.

With respect to the patenting of the moist combustion process by Mr. Cooper and myself, your remark that "Until 1893 the process is protected against practical criticism, and possibly against general adoption," embodies a strange variety of errors. It omits to take into account the little detail that, as a matter of fact, the patentees have not chosen to avail themselves of all their privileges, and have not prolonged the patent beyond the first seven years. That, however, is a very trifling detail compared with the insinuation that, because the Crown had granted to Mr. Cooper and to me a monopoly of our moist combustion, therefore the public would be deprived of the benefits arising from the working of the process.

Surely we have a right to ask, Where does your reviewer place the fault? Does he mean that we are so greedy that we will not grant licenses on fair terms? Or does he mean that contemporary chemists will only work processes when they are able to defraud the inventors of the remuneration which is due to them?—I am, &c.

J. ALFRED WANKLYN.

May 1, 1886.

[Most chemists who compare our notice of Mr. Wanklyn's works (CHEMICAL NEWS, vol. liii., p. 213) with the above letter will feel some surprise. As regards the "moist combustion process" we make no "insinuation," but we openly condemn, on principle, the step—unprecedented as we believe—of patenting an analytical process. Whether licenses under the Patent were readily obtainable or not, and on what terms they were granted, are, from our point of view, utterly irrelevant questions. We are glad to learn that the Patent has been suffered to lapse, and trust that it may now have a fair trial. So far many chemists have ignored it, not from any wish to "defraud the inventors," but by way of protest against the unusual step which the latter have taken.—ED. C. N.]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 7, April 1, 1886.

Foundation of an Establishment for the Treatment of Rabies.—This paper has no chemical bearings.

The Ptomaines and the Leucomaines.—Armand Gautier.—The first portion of a summary of a paper read by M. Gautier before the Academy of Medicine.

Effects of Zinc Sulphate upon the Organism.—M. Lepetit.—A poisoning case: a "sister" in charge of the pharmacy of the hospital department of a penitentiary administered to a patient by mistake 60 grms. zinc sulphate in place of sodium sulphate, which had been ordered by the visiting physician. After death the zinc was found to have been absorbed into the system. In mentioning that the "sister" was sentenced to a fine of a few francs, the writer asks what punishment would have been awarded to a pharmacist who had made so fatal a mistake?

On Potable Waters.—M. Lajoux.—The author determines the organic matter by the permanganate process; the albumenoid ammonia and ammonia by the method of Wanklyn and Chapman, and the nitric acid by the process of Grandval and Lajoux. He also examines microscopically and determines free oxygen by Gerardin's method.

The Composition of Wine-Brandies.—Ch. Ordonneau.—Alcohol distilled from wine contains normal butylic alcohol; in the spirit distilled from maize, beet-root, or potatoes there is found instead isobutylic alcohol, without a trace of normal butylic alcohol.

Experiments on Fatty Matters.—Ch. Dubois and L. Padé.—The authors have determined the solidification- and melting-points of the butter of various samples of cocoa, the solidification of the fatty acids, their proportion in the butter, and their solubilities in absolute alcohol at different temperatures.

Researches on Combustion.—Albin Figuier.—The author demonstrates that nitric and nitrous acids are formed during the combustion of olive oil, ethylic alcohol, and coal-gas. Pure hydrogen burning against a smoked wire gauze yielded hydrocyanic acid, but no nitrous or nitric acid.

Assay of Commercial Pepsines.—Everett Coombs.—From the *Pharmacist*.

Filtration of Potable Waters in the Household.—C. Méhu.—Descriptions and figures of some of the most popular filters, both of English and French makes.

Fehling's Liquor as a Reagent in the Clinical Analysis of Urine.—L. Jolly.—Fehling's liquor, according to the proportions used, may indicate the presence of peptones, of uric acid in excess, of phosphoric acid in excess in urines respectively poor or rich in uric acid, and of glucose. If 1 c.c. of Fehling's liquor is mixed with 8 to 10 c.c. of urine, shaken up, and boiled, the liquid may remain blue, which signifies nothing. But if it is decolourised with a pale yellow flocculent precipitate floating in the liquid, peptone is present. If the liquid turns orange and there is an orange precipitate, we have glucose. If equal parts of Fehling's liquor and urine are mixed in a test-tube and boiled and the clear liquid remains blue there is little uric acid, If it becomes green the urine contains an excess of uric acid or of a urate. If the precipitate is scanty there is little phosphoric acid, but if copious phosphoric acid is present in excess.

Die Chemische Industrie.
Vol. ix., No. 2, February, 1886.

Action of certain Acids, Alkalies, and Saline Solutions upon some of the Metals most employed in the Arts.—G. Lunge.—We have here an examination of the action of ordinary sulphuric acid upon cast-irons. The conclusion reached is that at ordinary temperatures and with exclusion of air the action of sulphuric acid, pure or commercial, at strengths of 66° to 50° B., is very insignificant, and noteworthy differences as regards the various qualities of iron could not be distinguished. At the boiling-point of water the action is much greater, that of acid at 66° B. being the slightest, that of acid at 60° B. 1½ times greater, and that of acid at 50° B. 3 times greater. The differences at tne boiling-points of the acids are much more decided. Acid of 66° B. has little more action at its boiling-point (295°) than at 100°; acid of 60° B. acts at its boiling-point (200°) on the average 14 times stronger than at 100°, and 20 times stronger than the 66° acid at 295°. The 50° B. acid, which at 100° acts twice as strongly as that of 60° B., acts at its boiling-point (147°) less strongly than that of 60° at 200°. In the second chapter the author examines the action of monohydrated sulphuric acid upon cast-iron, wrought-iron, copper, and lead. At common temperatures and at 100° there is very little action either upon cast- or wrought-iron if air is excluded. Copper and lead are strongly attacked at common temperatures, lead more than copper. At 100° lead is scarcely more affected than at 20°, whilst copper enters into violent reaction with escape of sulphurous acid. The third chapter gives an account of the action of saturated solutions of sodium chloride and ammonium chloride upon the same metals. With sodium chloride the attack is slight in all cases, but quite perceptible, especially on cast-iron, and at higher temperatures on lead. The action of ammonium chloride is much stronger. Contrary to the common opinion lead is much more attacked in the cold by a strong solution of sal-ammoniac than iron. At a boiling heat it resists rather better than iron but far worse than copper. Lastly, we find an account of the action of caustic soda-lye, sodium sulphide, and sulphate upon the same metals. Caustic soda has little action upon iron at 15° and 100°, but more upon wrought-iron than cast-iron. Upon copper the action is more considerable, and upon lead still more so if the lye is dilute. Sodium sulphide, even in dilute solution, has a much stronger action upon iron and copper. Upon lead the action is slight, even at 100°. Sodium sulphate has little effect upon copper and lead, but its action upon iron is considerable.

Revue Universelle des Mines, de la Metallurgie, &c.,
Vol. xix., No. 1, January and February, 1886.

Electrolysis in Metallurgy.—V. Zoppetti.—The author gives here a summary of the various electro-metallurgical procedures, and especially of the electrolytic method employed at the Casarza copper-works. The secondary products are sulphuric acid, iron sulphate, and silver.

MEETINGS FOR THE WEEK.

Monday, 17th.—Society of Arts, 8. (Cantor Lectures). "Animal Mechanics," by Dr. B. W. Richardson, F.R.S.
Tuesday, 18th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
—— Society of Arts, 8. "Japanese Art Work," by Ernest Hart.
Wednesday, 19th.—Society of Arts, 8. "Watchmaking by Machinery," by Prof. Leonard Waldo.
—— Meteorological, 7.
—— Pharmaceutical, 11. (Anniversary).
Thursday, 20th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Alkaloids," by Prof. Dewar, F.R.S.
—— Chemical, 8. Ballot for the Election of Fellows.
Friday, 21st.—Royal Institution, 9. "The Forms of Seedlings: the Causes to which they are Due," by Sir John Lubbock, F.R.S.
—— Society of Arts, 8. "Everyday Life of Indian Women," by Capt. R. C. Temple.
Saturday, 22nd.—Royal Institution, 3. "How to Form a Judgment on Musical Works," by Prof. Ernst Pauer.
—— Society of Arts, 3. "Electricity," by Professor George Forbes.
—— Physical, 3.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Amalgamation.—Can any correspondent tell me whether any other compound has been substituted for sodium amalgam in quartz and pyrites amalgamation for gold, and how I should obtain and use it.—J. D. A. S.

TO CORRESPONDENTS.

Mr. Hall.—H. Dussauce, "Manufacture of Vinegar and Acetometry," (Philadelphia, 1871). Dr. J. Bersch, "Essig Fabrikation" (Hartleben, Vienna).

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THE CHEMICAL NEWS.

VOL. LIII. No. 1382.

ELECTROLYTIC CONDUCTION IN RELATION TO MOLECULAR COMPOSITION, VALENCY, AND THE NATURE OF CHEMICAL CHANGE:

BEING AN ATTEMPT TO APPLY A THEORY OF "RESIDUAL AFFINITY."*

By HENRY E. ARMSTRONG Ph.D., F.R.S.

(Continued from p. 231).

Composite Electrolytes (continued).

THE evidence afforded by the oxy-acids derived from the halogens appears to me to be equally striking. The following are Ostwald's numbers, including those for nitric acid.

TABLE II.

v.	Nitric acid.	Chloric acid.	Perchloric acid.	Bromic acid.	Iodic acid.	Periodic acid.
2	77·9	77·9	79·1	—	42·57	
4	80·4	80·2	82·2	—	50·56	23·71
8	82·8	82·3	84·6	—	59·00	30·59
16	84·9	84·0	86·2	—	66·3	39·49
32	86·3	85·3	88·1	79·4	72·3	49·23
64	87·4	86·4	89·2	81·7	76·9	59·48
128	88·2	87·9	89·7	84·1	80·2	69·06
256	88·4	88·7	89·9	86·1	81·8	76·70
512	88·8	88·7	89·8	87·4	83·0	82·59
1024	88·9	88·6	89·8	88·4	83·1	85·38
2048	88·2	87·3	89·3	89·0	82·9	87·95
4096	86·6	85·7	87·8	88·8	81·8	86·62

It will be observed that nitric, chloric, and perchloric acids differ but little; that bromic acid has a considerably lower initial conductivity, and does not attain the maximum so soon; that iodic acid differs still more; and that the behaviour of periodic acid is altogether peculiar—being that of a polybasic acid, it may be added. Ostwald regards it as most surprising—"*in hohem Grade befremdlich*"—that periodic acid should be much weaker than iodic acid, and that the latter should be considerably inferior to iodhydric acid. To my mind their behaviour is absolutely what might be expected of these acids. Although the molecules in liquid nitric, chloric, and perchloric acids are probably not of the simple composition represented by the formulæ HNO_3, $HClO_3$, and $HClO_4$ respectively, the chemical behaviour of these acids does not indicate any great difference between them; owing, however, to the accumulation of oxygen atoms, perchloric acid may be expected to exercise a somewhat greater influence than chloric acid, as it actually does. Chemists are agreed that bromine has less affinity for oxygen than chlorine; hence it may be inferred that the oxygen in bromic acid would have greater residual affinity than the oxygen in chloric acid, and that, therefore, bromic acid would form complex aggregates more readily than chloric acid, and consequently have less influence in electrolysis than chloric acid. This is true in a much greater degree of iodic, and still more of periodic acid;† it is well known that the former not only yields salts of the type $M'IO_3$, but also acid salts such as KHI_2O_6; and that periodic acid forms a series of very complex salts.

The acids of phosphorus form another interesting series:—

TABLE III.

v.	H_3PO_2.	H_3PO_3.	H_3PO_4.
2	30·89	28·63	14·22
4	37·91	34·29	17·00
8	45·81	41·14	21·26
16	54·13	49·09	27·09
32	62·10	56·96	34·41
64	69·06	64·52	43·05
128	74·05	70·21	53·11
256	77·84	74·54	61·8
512	79·92	77·57	69·9
1024	81·00	79·11	75·4
2048	81·39	79·75	79·0
4096	80·48	79·07	79·8

These numbers afford to my mind the clearest possible evidence that we are dealing with complex molecules. It is especially noteworthy that the maximum never exceeds that of the monobasic acids,* even in the case of phosphoric acid, which is universally regarded as a tribasic acid, and that the *monobasic* hypophosphorus acid is the strongest and the *tribasic* phosphoric acid is the weakest. In very dilute solution phosphoric acid has less influence than even acetic acid, according to Kohlrausch.

It may be well also to quote Ostwald's numbers for sulphurous, selenious, sulphuric, and selenic acids.

TABLE IV.

v.	Sulphurous acid.	Selenious acid.	Sulphuric acid.	Selenic acid.
2	—	7·63	92 7	97·3
4	19·19	9·73	96·4	103·2
8	25·43	12·70	100·6	109·9
16	32·79	16·60	107·4	117·7
32	41·60	21·73	116·3	127·0
64	50·1	28·24	127·3	138·3
128	58·9	36·15	139·2	148·7
256	66·5	45·11	150·6	157·9
512	72·5	54·27	160·9	164·4
1024	77·1	62·79	169·1	169·7
2048	80·4	69·40	174·4	173·4
4096	83·6	73·58	177·1	174·4
8192	—	—	176 9	173·4

It will be observed that sulphuric and selenic acids are nearly alike in behaviour, the latter being somewhat more active in concentrated solutions; it is noteworthy that of all the polybasic acids studied by Ostwald, these are the only two containing a *single* negative radicle (SO_4,SeO_4) which exhibit a conductivity in excess of that which characterises the monobasic acids.†

The numbers obtained for sulphurous and selenious acids are deserving of study. Sulphur dioxide is far from being a perfect gas under ordinary conditions; in the liquid state it is probably rich in aggregates of SO_2 molecules, and these may be to a large extent conserved in concentrated aqueous solutions. But the main explanation of the variation in conductivity on dilution must be looked for, I think, in the peculiar relation which sulphur dioxide manifests to water; it is more than probable that the initial interaction involves the formation of a *hydrate* $(SO_2)x(OH_2)y$, and that from this on dilution is formed

* A Paper read before the Royal Society, March 25th, 1886.

† The existence of a stable oxide of the formula I_2O_5, as well as thermo-chemical data, have been interpreted as evidence that iodine has a greater affinity for oxygen than even chlorine. I am inclined to take the contrary view, however, and to regard the stability of the oxide I_2O_5 as due less to the high affinity of iodine for oxygen than to its low affinity for itself and the high affinity of oxygen for oxygen.

* Ostwald appears to be of the opinion that if the dilution could be carried far enough, a maximum conductivity = *n*·90 would eventually be attained in the case of every *n*-basic acid. It appears to me that neither do his numbers warrant this—and those here under discussion are an especially good illustration—nor is it likely to be the case on my hypothesis.

† Ostwald infers from the great increase in molecular conductivity that the manner in which the acid is electrolysed varies with the strength of the solution; he supposes that in more concentrated solutions sulphuric acid is resolved into H and HSO_4, and that both atoms of hydrogen are split off only as the solution becomes more diluted. This appears to me to be altogether improbable.

sulphurous acid, $SO(OH)_2$, and perhaps also "sulphonic acid," $H.SO_3H$. Taking into account the properties of selenious oxide, Ostwald's results appear to me in this case again to lead to but the one conclusion, that conductivity increases in consequence of the specific influence of the fundamental molecule of the compound making itself more and more felt, as by dilution it becomes more and more disentangled from its fellows.

The behaviour of solutions of neutral metallic salts on dilution is very similar to that of acids; abundant proof of this is afforded, especially by F. Kohlrausch's refined measurements, of which an account has recently been published (*Wied. Ann.*, 1886, xxvi., 162). I venture to think that a similar explanation to that above given for oxides will apply to salts; and also that the low molecular conductivities of salts as compared with corresponding acids may be regarded as confirmatory of my hypothesis. I think we must admit that the metals generally have less affinity than hydrogen for negative radicles; if this be granted we have at once an explanation of the fact that metallic salts are mostly fixed solids, few of which are more than moderately soluble in water, while many are very difficultly soluble and insoluble, whereas the corresponding acids are mostly volatile and readily soluble in water, if not miscible with it in all proportions. The affinity of the negative radicles being less exhausted by union with metals than with hydrogen, the fundamental molecules of salts are more prone to unite together to form complex aggregates.

Arrhenius, who has studied the electrical behaviour of solutions of a number of salts,* attributes the change observed in molecular conductivity on dilution—as I have done—to molecular changes; but his deductions are all based on the acceptance of the Williamson-Clausius hypothesis of dissociation.

My hypothesis would also account for the increase in conductivity in composite electrolytes with rise of temperature. It is true that as temperature rises the influence which individual molecules exert upon each other would be lessened; but, on the other hand, the complex aggregates would become more and more completely resolved into their fundamental molecules, the velocity of molecular motion would increase, and the tendency of the constituent atoms to remain united would be lessened. From this point of view the determination of the coefficient of change of conductivity with temperature in the case of substances whose molecular conductivity increases considerably on dilution in comparison with allied compounds which exhibit only a slight variation in molecular conductivity on dilution affords an interesting subject for investigation. F. Kohlrausch has already pointed out (*Pogg. Ann.*, 1875, cliv., 236) that in the case of all neutral salts, "der Einfluss der Temperatur auf das Leitungsvermögen mit wachsender Verdünnung sich Anfangswerthen nähert, die zwischen engen Gränzen liegen," and the experiments of F. Kohlrausch and Nippoldt on solutions of sulphuric acids (*Ibid.*, 1869, cxxxviii., 286) show that the resistance diminishes to a much greater extent for equal increments of temperature in concentrated than in dilute solutions. (See Table V.)

As concentrated solutions would be richer in complex aggregates than dilute solutions, these results are in entire accordance with my hypothesis: it does not appear to me that they can be satisfactorily interpreted in terms of the dissociation hypothesis.

In cases where the influence of the one member of the composite electrolyte upon the other is but slight, it may happen that the effect of temperature in diminishing this influence will outweigh that due to molecular simplification, and that, in consequence, conductivity will diminish with rise of temperature; a mixture of alcohol and ether would appear to furnish an example of this kind: according to Pfeiffer's recent observations (*Wied. Ann.*, 1885, xxvi., 226), such a mixture behaves as a metallic conductor of very high resistance.

TABLE V.

Percentage of sulphuric acid.	Resistance (Mercury=1).	Percentage increment of conductivity for 1° C.
0·2	465,100	0·47
8·3	34,530	0·653
14·2	18,946	0·646
20·2	14,990	0·799
28·0	13,133	1·317
35·2	13,132	1·259
41·5	14,286	1·410
46·0	15,762	1·674
50·4	17,726	1·582
55·2	20,796	1·417
60·3	25,574	1·794

The increase in conductivity of graphite and gas-retort carbon on heating, and the effect of light on the conductivity of (? impure) selenium and some other substances (Shelford Bidwell, *Phys. Soc. Proc.*, 7, cxxix., 256), appear to me to be also explicable on the assumption that in all these cases we are dealing with composite electrolytes.

If any further proof be needed of an intimate connection between molecular composition and electrolytic conduction it is most conclusively afforded, I think, by the observations of W. Kohlrausch on chloride, bromide, and iodide of silver (*Wied. Ann.*, 1882, xvii., 642), which are exhibited in the curves accompanying this paper. In the fused state these compounds are better conductors than the most highly conducting mixture of sulphuric acid and water, which of all liquids is the best conductor at ordinary temperatures. On reference to the curves it will be seen that the resistance of both silver chloride and bromide suddenly increases when the change from the fused to the solid state sets in; but that no such change takes place in the case of the iodide. Silver iodide fuses at 527° according to Rodwell, but at about 540° according to Kohlrausch; its electrical resistance increases only gradually after it has become solid, and remains almost a linear function of the temperature during an interval of 400°, until suddenly at near 150° it increases enormously, this change taking place at the moment when, according to Rodwell (*Phil. Trans.*, 1882, 1133), it passes from the transparent plastic amorphous solid to the opaque brittle crystalline state, the volume increasing considerably as shown by the curve. Kohlrausch has proved most conclusively that the solid iodide may undergo electrolysis. It would seem that almost immediately after solidification in the case of silver chloride and bromide, practically the whole mass consists of complex aggregates so constituted as to be exceedingly bad conductors, but that such aggregates are formed much less readily by silver iodide.

Metallic Conduction.

I do not propose in any way to discuss metallic conduction, but merely to call attention to some of the analogies between it and electrolytic conduction.

It is conceivable, and it would appear probable from the fairly regular manner in which the electrical resistance of most pure metals decreases as the temperature falls, the coefficients of change being practically very nearly the same in all cases, that the increase in resistance as temperature rises is mainly due to the increase in molecular inter-distances. As a rule, resistance increases on the passage of a metal from the solid to the liquid state, but there are noteworthy exceptions, from which it would

* *Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar.* Attonde Bandet. Häfte 2. Stockholm, 1884. Arrhenius, S.: "Recherches sur la Conductibilité Galvanique des Electrolytes. I. La Conductibilité Galvaniqne des Solutions Aqueuses extrémement diluées, determinée au moyen des Depolarisateurs." 63 pp. II. "Théorie Chimique des Electrolytes." 89 pp. Although aware of his work from Ostwald's reference to it, I was unable to study his memoir until after this paper had been elaborated. Ostwald's quotations, moreover, did not enable me to realise the importance which Arrhenius attaches to the occurrence of molecular simplification and changes in composition on dilution.

appear probable that even in pure metals conductivity to some extent depends on molecular composition; thus the conductivity of bismuth increases at the moment of fusion from 0·43 to 0·73 of that of mercury at 21°, and that of antimony from 0·59 to 0·84 (L. de la Rive, *Comp. Rend.*, 1863, lvii., 691); it is well known that bismuth contracts considerably on fusion, and this is probably also the case with antimony. Again, according to Bouty and Cailletet (*Ibid.*, 1885, c., 1188), the resistance of mercury decreases at the point of solidification in the ratio 4·08 : 1; this is a remarkable increase in conductivity, and it is difficult to believe that it is wholly due to mere contraction of volume.

That the behaviour of alloys is worthy of far more attention than it has hitherto received appears most clearly from the few data at disposal. As being the most instructive instance, I append the curve given by Professor Lodge, representing the specific conductivities of the copper-tin alloys (*Phys. Soc. Proc.*, 1879-80, iii., 158). He examined five alloys, containing respectively 80·8, 38·2, 31·7, 12·6, and 9·7 per cent by weight of tin, which were prepared by Professor Chandler Roberts; the dotted curve represents the results obtained by Matthiessen, who did not examine any alloy between those containing 16·4 and 85·1 volume per cent of copper. The comparison of Professor Lodge's curve with that given by F. Kohlrausch for mixtures of sulphuric acid and water—which I also append—appears to me to be in the highest degree suggestive. In the case of the latter it will be observed that, starting from SO_3 on the one side and H_2O on the other, minima occur at points on the curve corresponding to compounds of the formula H_2SO_4 and $H_2SO_4.H_2O$; it is, however, well known that such compounds are unobtainable at ordinary temperatures, and it is highly probable that if the *pure* compounds could be examined, the minima would touch the base line, as in the case of water. The point of maximum conductivity does not correspond to any known hydrate, but as I have elsewhere remarked it is almost coincident with that of maximum heat evolution on mixing sulphuric acid and water, and it is therefore doubtless the point at which the maximum chemical change occurs. On reference to the alloy curve it is seen that the addition of quite a small amount of tin to copper produces a very marked effect, just as does the addition of a small amount of water to sulphuric acid, the result being, however, to diminish conductivity in the one case but to increase it in the other; after the addition of only a moderate amount of tin a pronounced minimum is reached, corresponding to the pronounced maximum attained on addition of a moderate amount of water to sulphuric acid, and at a point moreover corresponding to a definite compound, $SnCu_4$. A further slight addition of tin develops another minimum less pronounced than the first, but also corresponding to a definite compound, $SnCu_3$; the curve then falls slightly and exhibits a third minimum, its course being analogous to that of the sulphuric acid and water curve near to sulphuric acid. If one or the other curve be inverted the general similarity in form is especially striking. It is obviously important that alloys intermediate between those studied should be examined; a comparison of Lodge's with Matthiessen's curve shows how much may be missed; this remark applies to alloys generally. Whatever may be the explanation,* it appears to me to be clear that in alloys as in composite electrolytes the constituent members of the system influence each other, and thus mutually contribute to the final result. The marked diminution in the conductivity of copper produced by very small quantities of oxygen, of phosphorus, and of the metalloid arsenic is well known. It would appear probable that this is in some way due to the occurrence of an electrolytic change, which at least in part is opposed in direction to that taking place in the pure metal during conduction.*

(To be continued).

* It is very remarkable that not only do the heat conductivity and the induction balance curves for the tin-copper alloys correspond (Chandler Roberts, *Phys. Soc. Proc.*, iii., 156), but that the curves given by Thurston as representing the strength of these alloys ("Materials of Engineering," Part III., p. 412) also exhibit a marked similarity to the electrical conductivity curves.

ON THE DETERMINATION OF ARSENIC.†

By LEROY W. MCCAY.

(Concluded from p. 234.)

HAVING worked so satisfactorily qualitatively, I determined to see whether this method of reduction could not be made to take the place of that suggested by Holthof, it being plain that, should its practicability prove incontestable, the Mohr-Holthof process would be wonderfully improved, especially in respect to the time necessary for making a reduction. When working according to Holthof, considerable quantities of sulphurous acid and *four* hours are requisite for complete reduction; whereas by subjecting the arsenic acid under pressure to the reducing influence of the sulphurous acid, the reduction is accomplished in *one* hour. It is just here that I propose to modify the method.

Since the reduction of arsenic to arsenious acid with sulphurous acid is, when all the details above indicated are strictly observed, not only complete, but also capable of being carried out in a remarkably short period of time it seemed feasible to make a few estimations of the element as the sulphide, this method of determining the arsenic being especially applicable in the case of a solution containing pure arsenious acid, and free from all substances possessing the property of acting in a reducing manner upon sulphuretted hydrogen.

The determinations were made by bringing the solution of H_2KAsO_4 into a little bottle of convenient size, adding somewhat over an equal volume of *strong* sulphurous acid and reducing, then boiling down one-half after transferring to a flask, and precipitating the arsenic in a beaker with freshly prepared sulphuretted hydrogen water. The solution when ready for precipitation should be moderately hot, strongly acid, and its volume should equal about 100 c.c. The freshly prepared and perfectly clear sulphuretted hydrogen water is to be added in slight excess, and the solution, after the addition of the same, heated on the sand-bath to about 80° to 85°, and kept at this temperature, with occasional stirring, until the precipitate of the sulphide settles completely, leaving the supernatant fluid clear, and emitting but a faint odour of sulphuretted hydrogen. The filtrates, although invariably examined, gave no evidence of the presence of arsenic.

Friedrich Mohr, in his *Lehrbuch der Titrirmethode*, IV. Auflage, s. 357, uses the following language: —"When the arsenic as arsenic trisulphide is once gotten upon the filter-paper, nothing is simpler than to dissolve the same off the paper in ammonic hydrate and evaporate the resulting solution to dryness in a watch-glass or porcelain dish. I have satisfied myself that *dry* arsenic trisulphide when weighed in a platinum dish, dissolved in ammonic hydrate, and again evaporated to dryness, gives exactly the same weight. From 0·243 grm. As_2S_3 I obtained 0·243 grm., from 0·643 grm. I got back 0·642 grm. It is only the filter-paper which hinders the weighing and drying, and this is here done away with." Neither Rose, Fresenius, nor Classen recommends this method of treating the precipitate of the sulphide, and I therefore thought it

* The change produced in gold by a very small quantity of lead is most astonishing: its conductivity is reduced almost to that of lead, and it becomes as brittle as glass. It is difficult to understand this change unless it be that opportunity is given for the gold itself to assume a different molecular state owing to continuity becoming disturbed. The effect produced appears to be strictly comparable with that observed on lowering the temperature of silver iodide from above about 150°, and in the passage of liquid water at 0° into ice.

† *American Chemical Journal*, vol. vii., No. 6.

well to put it to the test. I made six determinations, the ammoniacal solution being caught, evaporated, and weighed in a thin light platinum dish. The sulphide was not dried, but dissolved off the paper as soon as the washing was finished. Mohr's experiments were made on the *dry* sulphide, although from his directions one would conclude that he advocated too the direct application of the ammonia to the still moist precipitate. Whether or not correct results would be obtained by first drying and then dissolving the precipitate I am unable to say. The following are the results of my experiments:—

	St. Sol.	As_2S_3.	As.	As_2O_3.	As_2O_5.
1	10 c.c.	0·0965 grm.	0·0588 grm.	0·0776 grm.	0·0901 grm.
2	10	0·0955	0·0582	0·0768	0·0892
3	10	0·0963	0·0586	0·0774	0·0898
4	10	0·0945	0·0576	0·0759	0·0883
5	10	0·0985	0·0600	0·0792	0·0920
6	10	0·1003	0·0611	0·0806	0·0936

10 c.c. 0·0593 grm. As = 0·0782 grm. As_2O_3 = 0·0907 grm. As_2O_5.

The above results are not only incorrect, but they exhibit no constancy among themselves, in spite of the fact that in all cases extreme care was taken to work under like conditions. During the evaporation of the ammoniacal solution, one of the first things which attracted any attention was an evolution of sulphuretted hydrogen, which continued until the last traces of moisture had disappeared and the residue exhibited a perfectly dry appearance. The presence of the sulphuretted hydrogen could be distinctly indicated by the change of colour to brown, and in some cases almost to black, of a piece of filter-paper moistened with a little acetate of lead solution, and held over the platinum dish containing the solution of arsenic. The figures above given show conclusively that Mohr's proposal is inapplicable, at all events in the case of freshly precipitated and still moist trisulphide of arsenic. Numbers 1, 2, 3, and 4 are too low; number 5 is very nearly correct; while number 6 is too high. In Roscoe and Schorlemmer's "Treatise on Chemistry," vol. i., p. 538, I find that no less a man than Wöhler directs that the sulphide of arsenic obtained in *forensic work* be dissolved off the filter-paper in ammonia, the resulting solution evaporated in a dish, and the element weighed as the trisulphide, As_2S_3. *No mention whatever is made of its being necessary first to dry the precipitate.* It is a very remarkable fact that the evolution of sulphuretted hydrogen during the evaporation of the ammoniacal solution should have escaped the notice of Mohr and Wöhler, and it is likewise a remarkable fact that no one has yet seen fit to call attention to the inaccuracy involved in weighing the arsenic as the compound obtained by evaporating an ammoniacal solution of the trisulphide.

However, by following the usual method, collecting, drying, and weighing on a tared paper, very satisfactory results were obtained, as the figures below given will at once show. I find it well, after a thorough washing, to remove the adhering water by means of about 10 c.c. of absolute alcohol, so as to hasten the subsequent drying of the precipitate. The sulphide was weighed in a very light drying-box provided with a well-fitting ground-glass stopper.

	St. Sol.	As_2S_3.	As.	As_2O_3.	As_2O_5.
1	20 c.c.	0·1935 grm.	0·1180 grm.	0·1553 grm.	0·1810 grm.
2	20	0·1930	0·1176	0·1550	0·1802
3	20	0·1940	0·1182	0·1560	0·1812

20 c.c. = 0·1186 grm. As = 0·1564 grm. As_2O_3 = 0·1814 grm. As_2O_5. With 50 c.c. H_2KAsO_4 solution I obtained 0·4869 grm. As_2S_3 = 0·2963 As = 0·391 As_2O_3 = 0·4527 As_2O_5.

I shall now retnrn to my modification of the Holthof method of reduction.

To avoid, then, the large quantities of sulphurous acid necessary when working according to Holthof, and, moreover render it possible to effect the reduction of the arsenic from the maximum to the minimum stage of oxidation in one-fourth the time hitherto considered requisite, I suggest that Holthof's method be so modified that the reduction be accomplished in hermetically sealed bottles and at a temperature equal to that of boiling water. Qualitative as well as gravimetric quantitative experiments have already proved the reduction to be fully as complete as the one proposed by Holthof; and since its advantages over the Holthof method have been clearly pointed out, it only remains for me to offer a number of test analyses, obtained under various conditions, by titrating different quantities of known solutions of reduced arsenic acid with $\frac{1}{10}$ normal iodine.

A. 1.—In making the following lot of tests the solution of H_2KAsO_4 was brought into a small bottle provided with a well-fitting ground glass stopper, and capable of holding when filled 50 c.c.: 20 c.c. of sulphurous acid were added, the bottle was tightly stoppered, and the stopper firmly tied down with a piece of stout cord. The bottle with its contents was then placed in the *briskly* boiling water-bath, and here permitted to remain for exactly one hour. At the end of this time the bottle containing the arsenious acid was removed from the bath, permitted to cool to such a degree that it caused no inconvenience when held in the hand, and then carefully opened. The solution was emptied into a small flask, the bottle well rinsed out with pure water, and the entire liquid diluted to 150 c.c. After introducing the platinum spiral, boiling down to one-half the original volume, cooling, and diluting to 300 c.c., the arsenic was determined by titrating with $\frac{1}{10}$ normal iodine in the manner already described.

A. Using 5 c.c. H_2KAsO_4 solution, 20 c.c. sulphurous acid, and reducing as above, I obtained—

No.	St. Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	5 c.c.	15·80 c.c.	0·0297 grm.	0·0392 grm.	0·0456 grm.
2	5	15·80	0·0297	0·0392	0·0456
3	5	15·65	0·0294	0·0389	0·0452
4	5	15·75	0·0296	0·0391	0·0455
5	5	15·80	0·0297	0·0392	0·0456
6	5	15·65	0·0294	0·0389	0·0452
7	5	15·80	0·0297	0·0392	0·0456
8	5	15·80	0·0297	0·0392	0·0456
9	5	15 70	0·0295	0·0390	0·0453

5 c.c. = 0·0296 grm. As = 0·039 grm. As_2O_3 = 0·0453 grm. As_2O_5.

2. Using 10 c.c. HK_2AsO_4 solution, 20 c.c. sulphurous acid, and reducing, I obtained—

No.	St. Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	10 c.c.	31·4 c.c.	0·0591 grm.	0·0781 grm.	0·0907 grm.
2	10	31·5	0·0593	0·0783	0 0910
3	10	31·5	0·0593	0·0783	0·0910
4	10	31·45	0·0592	0·0782	0·0908
5	10	31·5	0·0593	0·0783	0·0910
6	10	31·4	0·0591	0·0781	0·0907

10 c.c. = 0·0593 grm. As = 0·0782 grm. As_2O_3 = 0·0907 grm. As_2O_5.

3. Using 20 c.c. H_2KAsO_4 solution, 30 c.c. sulphurous acid, and reducing, I obtained—

No.	St. Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	20 c.c.	62 5 c.c.	0·1177 grm.	0·1556 grm.	0·1805 grm.
2	20	62·7	0·1181	0·1559	0·1811
3	20	62 65	0·1180	0·1557	0·1808

20 c.c. = 0·1186 grm. As = 0·1564 grm. As_2O_3 = 0·1814 grm. As_2O_5.

B. To test the method still further, six determinations were made with the solution containing 2·475 grms. As_2O_3,

as As_2O_5, in a litre. 20 c.c. were used in each test, and the reduction was effected in the usual way. I obtained—

No.	St. Solut'n.	1-40 Normal Iodine.	As.	As_2O_3.	As_2O_5.
1	20 c.c.	19·9 c.c.	0·0375 grm.	0·0495 grm.	0·0575 grm.
2	20	19·8	0·0373	0·0492	0·0572
3	20	19·8	0·0373	0·0492	0·0572
4	20	19·85	0·0374	0·0493	0·0573
5	20	19·8	0·0373	0·0492	0·0572
6	20	19·8	0·0373	0·0492	0·0572

20 c.c. = 0·0375 grm. As = 0·0495 grm. As_2O_3 = 0·0575 grm. As_2O_5.

These figures are a trifle lower than those obtained when the reduction was effected by Holthof's method. 20 c.c. of the above solution should require exactly 19·9 c.c. $\frac{1}{40}$ normal iodine, whereas the quantity actually used when following Holthof's directions was 20·1 c.c. I have already given good reasons for believing that in this case the excess of iodine is due to organic substances which are present in the large quantities of water necessary in making a test in accordance with the first method.

Some time last year we received from a firm in Philadelphia a sample of what purported to be arsenic acid, c.p. A quantitative test proved, however, that it was in nowise chemically pure arsenic acid, but a mixture of arsenious and arsenic acids. The comparatively small precipitate obtained with magnesia mixture indicated clearly that the arsenious acid was the principal constituent. The article is in lumps, some of which, owing to their porcelain-like appearance, are immediately recognised as arsenious acid. I have examined this *so-called* arsenic acid by my modifications of the Reich and Mohr-Holthof methods, and in the following manner :—A portion of the material was finely pulverised, 3·0 grms. were carefully weighed out, dissolved in a little warm caustic potash, and diluted to a litre. 20 c.c. were then brought into a beaker, evaporated to dryness upon the water-bath three times with fuming nitric acid, and the arsenic determined according to my last modification of the Reich process. I obtained 0·0558 grm. As_2O_3, which represents the total arsenic calculated to arsenious oxide.

In the following table I give the results of six determinations of the actual amount of As_2O_3 present, each determination being made according to Mohr, and with 20 c.c. of the original solution :—

No.	Solution.	1-40 Normal Iodine.	As_2O_3.
1	20 c.c.	18·2 c.c.	0·0452 grm.
2	20	18·15	0·0451
3	20	18·2	0·0452
4	20	18·2	0·0452
5	20	18·25	0·0453
6	20	11·15	0·0451

Since 20 c.c. = 0·0452 grm., 1000 c.c. = 2·260 grms. As_2O_3, or 3·0 grms. substance = 2·26 grms. As_2O_3, which gives 75·33 per cent As_2O_3.

The table below presents the results of six more determinations, the 20 c.c. solution taken being first reduced under pressure with sulphurous acid, then boiled down one-half, and finally titrated :—

No.	Solution.	1-40 Normal Iodine.	As_2O_3.
1	20 c.c.	22·6 c.c.	0·0562 grm.
2	20	22·6	0·0562
3	20	22·4	0·0557
4	20	22·4	0·0557
5	20	22·4	0·0557
6	20	22·4	0·0557

As present as As_2O_3, according to Reich, 0·0558 grm ; 0·0557 − 0·0452 = 0·0105 grm. arsenious acid present as arsenic acid. Inasmuch as 99 As_2O_3 = 115 As_2O_5, 0·0105 grm.

$$As_2O_3 = \frac{115 \times 0{\cdot}0105}{99} = 0{\cdot}0122 \text{ grm. } As_2O_5.$$

Since 20 c.c. = 0·0122 grm. As_2O_5, 1000 c.c. = 0·610 grm., or 3·0 grms. substance = 0·610 grm. As_2O_5, which gives 20·33 per cent As_2O_5. The rest is undoubtedly moisture. A small sample of the substance when heated gently in a glass tube closed at one end gave quite a strong reaction for water.

In closing I would like to say that, although the Mohr-Holthof method is most admirably adapted for estimating arsenic in such compounds as soluble salts, yellow and red arsenic glass, and mixtures of arsenious and arsenic oxides, for determining the element in minerals, speisses, mattes, and slags, the modified Reich method is, to my mind, much to be preferred. The latter method, though possibly not so *scientifically* perfect as the former, is certainly more rapid, convenient, and practical. Above all things it is singularly well suited for determining arsenic in the various kinds of metallurgical products. I have almost finished an exhaustive examination of this method, and I trust ere long to be in the position to describe the results obtained.

ON THE

UNIT USED IN CALCULATING THE ATOMIC WEIGHTS.*

By LOTHAR MEYER and KARL SEUBERT.

THE controversy arising immediately after the proposal of Dalton's atomic theory, as to the unit upon which the numerical values of the atomic weights should be based, has for a half-century divided chemists into two schools. While Dalton and later Leopold Gmelin, from theoretical and philosophical considerations, chose the smallest atomic weight, that of hydrogen, as the measure of all the rest, Wollaston and Berzelius chose that of oxygen, partly because they did not place so high a value on theoretical views, partly and especially on the purely practical ground that many elements can be compared directly with oxygen, whereas they can be only indirectly compared with hydrogen. When the Dalton unit, the hydrogen atom, gradually obtained the upper hand, the old controversy appeared to have been laid aside, and consequently it was to be hoped that the recent more exact investigations of the laws which govern the numerical values of the atomic weights would be directed from the same point of view.

This hope, however, has unfortunately not been fulfilled, as the old Wollaston-Berzelius unit has lately again come into use in a different, and as we believe more dangerous, form.

As is well known, J. S. Stas† has, from his own observations as well as those of others, deduced, as the most highly probable result, that the atomic weight of oxygen is not quite sixteen times as great as that of hydrogen, but, on the contrary, is about 1-400th of its value less than 16H. This follows :—

(1) From the numerous gas analyses (reduced to weight) conducted since the discovery of Gay-Lussac and Von Humboldt, or, what amounts to the same thing, from Avogadro's law and the experimentally determined densities of both gases (No. 1 *a*,‡ and Julius Thomsen, *Berichte der Deutschen Chemischen Gesellschaft*, iii., 927) ;

(2) From the synthesis of water by means of copper oxide (*loc. cit.*, No. 1 *c*, *d*) ;

(3) From the relations of sal ammoniac to silver nitrate and of both to silver (*ib.*, No. 47 and 83), where, as confirmatory of the atomic weight of nitrogen (N = 0·87791O) used in the calculations, the relations of the chlorides and metals to the nitrates could also be determined (No. 131,

* Translated by W. S. Bayley from an article in the *Berichte der Deutschen Chemischen Gesellschaft*, xviii., 1089.

† "Nouvelles Recherches sur les Lois des Proportions Chimiques." Bruxelles, 1865, p. 24, &c.

‡ "Die Atomgewichte der Elemente aus den Originalzahlen berechnet," von L. Meyer und K. Seubert. Leipzig, 1883.

132, 133, 135); and further, though with somewhat less certainty,

(4) From the relation of the crystallised and dehydrated strontium chlorides to each other and to silver (No. 65 *c* and 140);

(5) From the relation of these substances to each other and to the sulphate (No. 197);

(6) From the corresponding numbers for crystallised and dehydrated barium chloride and silver (No. 66 *e* and 141);

(7) From the relation of both forms of barium chloride to the sulphate (No. 188 *d*);

(8) From the relation of aluminium to hydrogen and to water (No. 8 *c*, *d*, and 144).

The determinations deduced from methods 1 and 2, undoubtedly the most exact, give as a mean the ratio—

$$H : O = 0{\cdot}06265 : 1 = 1 : 15{\cdot}96,$$

which Stas considered as coming nearest to the truth. The simple ratio of 1 to 16 demanded by Prout's hypothesis in one sense lies entirely outside of the observed values, in another sense very near to their extreme limits. To an unprejudiced judge not biassed in favour of that hypothesis, not yet established by the best observations, there appears no ground for accepting this numerical relation rather than that obtained as the mean value.

Further, if the simpler ratio be accepted, the experiments embraced under the heads from 3 to 8 yield results almost all of which agree less well than if the more complex ratios were accepted, and the differences between the calculated values and those obtained under 3 are greater than could be accounted for on the supposition that they are due to errors of observation.

But since this relation between the atomic weights of hydrogen and oxygen had not yet been as accurately determined as that of other elements to one another, Stas, in order to show the utter indefensibility of Prout's hypothesis, calculated all the atomic weights determined by him upon the assumption, *incorrect according to his opinion*, that the atomic weight of oxygen is just sixteen times as great as that of hydrogen. He pointed out that, even with this assumption, Prout's hypothesis would not hold good for the rest of the atomic weights under investigation. This supposition, made by Stas merely for the sake of argument, appears to have been much misunderstood; as if the value O = 15·96 and O = 16·00 were exactly the same, which of course is not at all the case. It is rather in a high degree probable, if not certain, that the number 16 is incorrect to 3 or 5 units in the second decimal place, whereas the other value, 15·99, is out only 1 or at the most not more than 2 units.

Since we were at that time accustomed to reckon with O = 16, and Stas naturally discussed only those atomic weights which had been newly determined by him, the choice was offered whether to calculate all atomic weights with the corrected values of oxygen, silver, chlorine, &c., as a basis, or provisionally to manage further with the old numbers, and merely introduce the corrected atomic weights of Stas into a system resting upon a somewhat more defective basis. This last, incorrect indeed, but more convenient way, was chosen by many chemists. This could the more easily be done since most of the atomic weights in use at that time were justly looked upon as not being very accurate, and a difference of 1·400th of a value was of very little practical consideration.

The hope that at least the old controversy over the choice of the unit would disappear upon a re-calculation of the atomic weights of all the elements has unfortunately not been fulfilled. There is a universal desire to do away with the unit preferred by Thomsen, Wollaston, and Berzelius,—

$$O = 1, = 10, \text{ or } = 100,$$

and to refer all atomic weights to hydrogen. But as to the way in which this should be done opinions differ. With a few exceptions (as in the case of Al, No. 8 *c*, *d*) the relation to hydrogen is deduced only through the intervention of oxygen,—consequently the numerical values of all atomic weights depend upon that of oxygen. In consideration of this we have, in our re-calculation of the atomic weights referred to above, made use of the Wollaston-Berzelius unit (O = 1), as well as the usual one (H = 1), so that in case of a new, more trustworthy determination of the relation O : H, the numbers referred to hydrogen as 1 could easily be corrected. A few years earlier G. F. Becker* referred all the atomic weights to O = 16. F. W. Clarke† has, like us, taken H = 1, but has also, out of fondness for Prout's hypothesis, given a table in which O = 16, and consequently H = 1·0023. J. Sebelin‡ makes use of the same units as we do (H = 1 and O = 100), and only occasionally adds a few numbers calculated on the supposition that O = 16. W. Ostwald§ does not agree with Stas that the value O = 16 is too large, but thinks that, from the last five observations of Erdmann and Marchand,‖ the first three of which he casts aside, it must follow that for H = 1, O must be exactly 16·00, though the sum of all the experiments of these authors gives O = 15·96. J. D. van der Plaatz¶ inclines to the view that O may be equal to 16, though he considers the question as still open. W. Dittmar** has re-calculated the atomic weights, calculated by us on the basis H = 1, on the basis O = 16, and H = 1·0024.

In consequence of these different views all the other atomic weights fluctuate to the extent of about ½ per cent of their value, amounting in the case of the largest to one-half of the unit. That such a condition of things is undesirable all scientific men are agreed, and also that the very smallness of the difference aids in the confusion and perplexity, since every author will not state, in every article, the standard according to which he calculates.

How the evil is to be remedied is difficult to say. First of all it is to be remembered that both values for the atomic weight of oxygen lie within the limits of errors of observation, and that, in case authenticated constant errors tend to lower the result, it may even be admissible to take the maximum value O = 1603, instead of the mean value O = 15·96. It is more questionable, however, to round off this maximum value just at the number 16, for which there are no grounds except the unproven Prout's hypothesis. The secret or confessed fondness for this hypothesis is probably the true cause of the choice of this number. We willingly acknowledge that there may be concealed in this hypothesis of Prout's a valuable idea; but this does not change the fact that, *as now stated, the hypothesis is untenable*. Wherever, up to this time, the proof has been looked into with sufficient exactness, it has shown that the atomic weights are not exact multiples of whole numbers, and this result is independent of the relation of oxygen to hydrogen. Accept this or not, as we will, we always obtain for the atomic weights, when most accurately determined, irrational numbers.

What seems to be most noteworthy in Prout's hypothesis is brought into view, and in an unprejudiced manner, when we take the relation of H : O as given by the most accurate observations. For instance, it is a striking fact that that the atomic weights of more than one-fourth of all the elements are very nearly multiples of the half atomic, or equivalent weight of oxygen, as the Table will show. (See next page).

Such regularities are worthy of note; but to attempt to correct the atomic weights by them would be just as incorrect as to round them off into whole numbers.

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* "Atomic Weight Determinations: a Digest of the Investigations published since 1814." Washington, Smithsonian Institution, 1880.

† "A Re-calculation of the Atomic Weights." Washington, Smithsonian Institution, 1882.

‡ "Beitrage zur Geschichte der Atomgewichte." Preisschrift, Braunschweig, 1884.

§ "Lehrbuch der Allgemeinen Chemie." Leipzig, 1884.

‖ Meyer and Seubert, No. 1 *d*; Clarke, p. 5.

¶ *Comptes Rendus*, Jan. 5, 1885, 100.

** "Tables to facilitate Chemical Calculations." 2nd Ed. Glasgow. 1885.

Multiples of ½O=7·98.

Factor.	Product.	Atomic Weights.	Difference.
1	7·98	—	—
2	15·96	O = 15·96	0
3	23·94	Mg = 23·94	0
4	31·92	S = 31·98	+0·06
5	39·90	Ca = 39·91	+0·01
6	47·88	Ti = 48·01	+0·13
7	55·86	Fe = 55·88	+0·02
8	63·84	(Cu = 63·18)	(−0·66)
9	71·82	Ekasilicon.	—
10	79·80	Br = 79·76	−0·04
11	87·78	(Sr = 87·3)	(−0·48)
12	95·76	Mo = 95·9	+0·14
13	103·74	Ru = 103·5	−0·24
14	111·72	Cd = 111·7	0
15	119·70	Sb = 119·6	−0·10
16	127·68	—	—
17	135·66	—	—
18	143·64	Di = ?	—
19	151·62	Break in VI.	—
20	159·60	—	—
21	167·58	Eb = ?	—
22	175·56	Break in IV.	—
23	183·54	W = 183·6	+0·06
24	191·52	Os = ?	—
25	199·50	Hg = 199·8	+0·3
26	207·48	Bi = 207·3	−0·18
27	215·46	—	—
28	223·44	—	—
29	231·42	Th = 231·96	+0·54
30	239·40	U = 239 8	+0·4

He who does not adhere to Prout's hypothesis, and is besides not of the opinion that the observations yield as the most probable value of the relation O : H = 16 : 1, has, according to our view, not the least ground for giving the value O = 16 the preference over O = 15·96. Then, if we take the atomic weight of oxygen, not as = 1 or = 10 or = 100, but as = 16, the only meaning that can be attached to it is that it appears more proper to take the hydrogen atom as the unit. This view is universally held; but since its relation to oxygen is uncertain to a few thousandths of its value, it is thought that the round number 16 may be used instead of the 15·96 found, though it is necessary in this case to place H = 1·0025, *i. e.*, to take as the unit $\frac{1}{1\,0\,0\,2\,5}$ of the atomic weight of hydrogen. Such a wonderful unit can only be endured in the quiet hope of the future fulfilment of the hypothesis of Prout. In the end hardly anyone will seriously wish Science to be burdened with it.

It is admitted that with the atomic weight of oxygen uncertain, all others remain so likewise in the fourth and following places of their numerical values, while their relative values, their relations to one another, in many cases are correctly determined to the fourth, and in some cases even to the fifth, place. These facts can be changed by no hypothetical considerations. If to-morrow the relation O : H should be determined more accurately to the one or two thousandth part of its value, and this number should differ from the one accepted to-day, all the other atomic weights would have to be re-calculated.

What advantage is offered in calculating with H = 1·0025 and O = 16 we cannot possibly see. The fact that the numerical values for oxygen, carbon, and a few other elements are thereby reduced to two figures, can hardly appear so desirable that one should, for this reason, consent to the choice of such a nonsensical unit.

It has been stated that the error which would be introduced by making H = 1 is much smaller than the unavoidable errors of observation.

But so far as this is concerned it may, on the other hand, be asked—Why introduce even so small an error when it can be avoided? Our observations are, without this, already sufficiently subject to sources of errors of all kinds. It does not change the case at all if the omission of these small fractions does *not* influence the decimal places which are generally considered in analysis. If for most *inorganic* compounds no difference of importance is effected, in the case of the analysis of *organic* compounds it is otherwise.

In this field no one would be expected to reckon with H = 1·0025. After H has once been decided upon as = 1, it makes quite a difference in the result whether O is taken as 15·96 and C as 11·97, or O as 16 and C as 12. In some cases this difference is greater than the difference in the composition of closely related compounds.

The table given below shows the percentages of hydrogen and carbon in the paraffins containing 30 and 31 carbon atoms and their derived alcohols and acids (myricyl alcohol and melissic acid*), and also the amount of water and carbon dioxide produced in their combustion. Under *a* are the results calculated with O = 15·96, C = 11·97; under *b* with O = 16 and C = 12.

Thus we see that the amount of water remains almost the same in each calculation because the variations compensate each other; the hydrogen, on the other hand, varies a few hundredths, as does also the carbon, while the variations in the carbon dioxide reach the tenths of a per cent, *a difference which is often greater than that obtained from two adjacent hydrocarbons in a homologous series*. This last is more clearly seen if we calculate by both methods the percentages of carbon and dioxide contained in a series of hydrocarbons, and place them together as is done in the following Table :—(See next page).

This shows that the different calculations *a* and *b* may lead to different interpretations of the analyses. If, for instance, the combustion of a hydrocarbon yields 312·51 m.grms. of carbon dioxide for every 100 m.grms. of substance, the advocate of Prout's hypothesis will find that the formula $C_{25}H_{52}$ best expresses the result of the analysis, while according to Stas and his followers it indicates the formula $C_{27}H_{56}$. Of course no one would determine the formula of such a body by means of analysis alone; still one is accustomed, in the choice of formulas, to lay a certain weight on the mean result of a series of closely agreeing analyses, and this would here lead to a false conclusion if an error of a few thousandths in the atomic weight of hydrogen were not thought worthy of account.

Those who think with us that the determinations thus far submitted render more probable the relation—

O : H = 15·96 : 1 = 1 : 0·06265,

than that demanded by Prout's hypothesis,—

O : H = 16 : 1 = 1 : 0·06250,

* *Cf.* F. Schwalb, "Ueber die nicht sauren Bestandtheile des Bienenwachses" Inaug Diss. Tubingen, 1884.

	H_2O.		H.		CO_2.		C.	
	a.	*b.*	*a.*	*b.*	*a.*	*b.*	*a.*	*b.*
$C_{30}H_{62}$	132·22	132·23	14·723	14·692	312·68	312·80	85·277	85·308
$C_{31}H_{64}$	132·10	132·11	14·710	14·679	312·73	312·84	85·290	85·321
$C_{30}H_{62}O$	127·39	127·40	14·186	14·155	301·26	301·37	82·163	82·192
$C_{31}H_{64}O$	127·42	127·43	14·190	14·159	301·66	301·77	82·272	82·301
$C_{30}H_{60}O_2$	119·46	119·47	13·303	13·274	291·94	292·04	79·620	79·646
$C_{31}H_{62}O_2$	119·74	119·74	13·334	13·305	292·61	292·70	79·802	79·828

		$C_{24}H_{50}$.	$C_{25}H_{52}$.	$C_{26}H_{54}$.	$C_{27}H_{56}$.	$C_{28}H_{58}$.	$C_{29}H_{60}$.	$C_{30}H_{62}$.
C	*a*	85·176	85·196	85·214	85·232	85·248	85·263	85·277
	b	85·207	85·227	85 246	85·263	85·279	85·294	85·308
CO_2	*a*	312·310	312·384	312·452	312·516	312·575	312·630	312·681
	b	314·426	312·500	312·5 8	312·632	312·690	312·745	312·796

are guilty of a dangerous inconsistency when they operate with such atomic weights as—

O = 16, C = 12, Cl = 35·46 or even 35·5, &c.

These may, of course, be used in the laboratory for the calculation of approximate results, as in the case of preparing substances; but when it comes to calculating accurate analyses they should not be used.

We may ask of the admirers of Prout's hypothesis whether the universal acceptance of a uniform basis for all atomic weight determinations is not of much more value than a supposition which, in a few cases, may possibly not be entirely erroneous.

We are all convinced that the relation under consideration (and thereby every other atomic weight referred to H = 1) is not accurate to the thousandth part of its value. Let us accept it without artificial interpretations, just as it is yielded as the mean value of agreeing results obtained in many different ways, and wait till the future for its further proof and confirmation by experimental methods. As soon as this is accomplished we will be ready, among the first, to accept any changes in the values of the atomic weights as now calculated that may then be deemed necessary.—*American Chemical Journal.*

TWO NEW FILTERS AND A NEW ASPIRATOR.*

By P. CASAMAJOR.

I PROPOSE to describe two new filters which I have lately used with advantage, and also an apparatus for starting an aspirator. This apparatus may be applied to one of the new filters described or to others working in a similar manner.

One form of filtering apparatus is shown in section in Fig. 1. The vertical portion is a tube open at the top. The horizontal portion is a circular disc provided with a few holes to establish communication between the upper and lower surfaces of the disc. Below the disc horizontal openings are made to allow the vertical tube to communicate with the space below the disc. The vertical tube may have the same diameter throughout, but the walls of the tube are thicker in the lower portion than in the middle, and in this thicker than in the upper. The tube does not taper uniformly on the outside, but there is a shoulder between each portion and the one above it, the lower shoulder being designed to hold the disc in its place.

The filtering medium used with this apparatus is a circular piece of cloth, the centre of which is placed under the vertical tube. The cloth is folded over the edge of the disc, so that the edges of the cloth meet above the shoulder between the middle and upper portion of the tube. These edges are fastened above this shoulder by means of a string or a wire. The upper portion of the vertical tube may then be connected with a rubber tube.

To use this apparatus it may be placed in a vessel containing the liquid to be filtered. The rubber tube attached to the vertical tube may pass over the edge of the tank and be prolonged downwards on the outside below the position of the filter in the liquid. The syphon formed in this way may be started by suction. The liquid to be filtered passes through the cloth and outwards through the rubber tube.

* From the *Journal of the American Chemical Society*, vol. vii., No. 4.

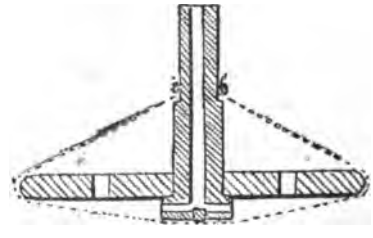
Wood is the most convenient material for making this filter. It has the drawback that it floats, which may be remedied by attaching a weight to the portion shown in Fig. 1.

For certain purposes this portion may be made of metal—iron, lead, tin, &c. Instead of pure lead, an alloy of lead 90 parts, antimony 10 parts, tin 5 parts, will be found to be harder and sufficiently tough.

This filtering apparatus is applicable to manufacturing operations on a small scale rather than to laboratory work.

The second form of filter is one which I have had in use for some time. I have named it the *sand poultice*. It is a bag full of sand *through* which the liquid to be filtered has to pass. The bag holding the sand is made of two circular pieces of cloth, whose edges are sewn to a strip of cloth about 1½ inches wide. After this bag has been filled with sand it has the shape of a flat circular box.

Fig. 1



When in use this sand poultice must lie on a perforated surface in a cylinder. The poultice is made of such a size that, when pressed down on the perforated surface, the vertical edge, formed by the strip of cloth, presses tightly against the cylindrical surface. It is to obtain this tight fit that the strip of cloth is used, and that the bag has not been made by sewing together the edges of the two circular pieces of cloth.

When this filter was first used it was found impossible to dislodge a certain amount of air which inflated the upper covering of the sand poultice. This was afterwards avoided by making a slit in this portion of the cloth through which the air escaped. A certain portion of dirt is in consequence deposited on the sand instead of on the cloth; but this has not been found practically objectionable.

Under the perforated plate supporting the sand poultice is a space for the collection of filtered liquid, which may very conveniently be let out by a faucet. With the sand may be mixed powdered charcoal, bone-black, &c. The sand poultice may be taken out and washed as often as is desirable, and the bag may be refilled when necessary.

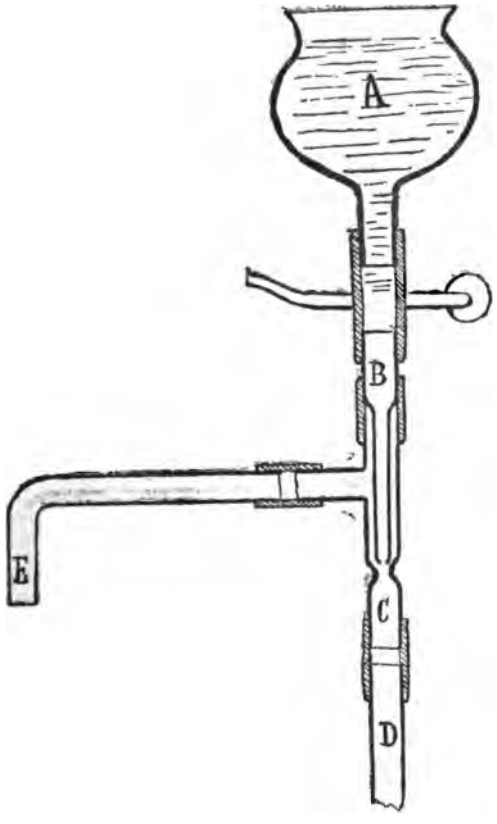
During the late period of turbidity in the Brooklyn water supply I have had occasion to use the sand poultice for filtering water for domestic use. I have found it advantageous to have a layer of fine gravel on top of the poultice, to arrest the greatest part of the muddy deposit and prevent it from obstructing the cloth. This gravel was taken out and washed twice a week without disturbing the rest of the filter. After being washed, the gravel was put back on top of the bag. After doing this five times it was found necessary to take out the poultice itself to wash the cloth covering.

Apparatus for Starting a Syphon.

This apparatus was suggested by a very ingenious ar-

rangement used in Dr. E. R. Squibb's acetic acid works. I have his permission for describing it here. In these works the acid is stored in very large stoneware receivers, which have no opening at the bottom, but they are provided with two tubulures on top. Through these tubulures pass glass tubes which go to the bottom of the receivers. Every tube is connected with a similar one on the receiver next to it by means of a bent connecting-tube. These three tubes, held together by means of rubber tubes, form an inverted U. On top of the bent tube is a tubulure over which passes a rubber tube, which is closed or opened by means of a pinch-cock. Through this tubulure the inverted U is filled by pouring in acid, after which the pinch-cock is closed. The last tube of a train connects in a similar manner with a vertical glass tube which extends to the storey below. This vertical tube ends, on its

Fig. 2



upper portion, in a T, one branch of which connects with the tube in the last receiver of the train. The upper end of the T has a rubber tube over it, which is closed with a pinch-cock. When it is desired to draw acid from the train of receivers, this pinch-cock is opened, and acid is poured in a funnel above the pinch-cock. The vertical tube is filled, the pinch-cock closed, and the acid, in running down, forms a syphon, by which the receivers are emptied, either wholly or in part, as may be desired. When sufficient acid has run out the pinch cock over the long vertical tube is opened, air is admitted, and the flow ceases.

The apparatus shown in Fig. 2 is made by connecting a thistle tube to a tube B by means of a rubber pipe closed by a pinch-cock. The lower end of tube B is placed above a reduced portion of tube C. When water runs down from the thistle tube by opening the pinch-cock, an aspiration is produced in tube C. The horizontal branch of the T tube C connects with a filtering apparatus, which may be the one represented in Fig. 1. It is also applicable to Dr. Carmichael's filter, or to the filter described by me in the *Journal of the American Chemical Society*, vol. iii., p. 125, in which the vertical tube causing aspiration is filled by suction from a flask, but the apparatus shown in Fig. 2 is much more convenient.

After filling the thistle tube with distilled water the pinch-cock is opened, and the water rushing downwards from tube B produces a vacuum in tube C connecting with a filter. This soon becomes filled with filtered liquid. In the apparatus in use in my laboratory 3 or 4 c.c. of water are sufficient to start the action by filling the vertical tube below tube C.

This apparatus differs from the one used in Dr. Squibb's works, by the use of the tube B and the narrowing of the tube C below the end of tube B. This addition was found necessary, because when the tube B is not used the opening of the pinch-cock below the thistle tube causes a momentary increase of pressure in the tube C until the vertical tube below C has been filled. This disarranges the asbestos on the platinum plate in the filter described in the *Journal of the American Chemical Society*, vol. iii., p. 125, and the operator is put to much trouble.

ELECTROLYTIC DETERMINATION OF MERCURY.

By DON LUIS DE LA ESCOSURA.

First Process.—The author operates upon about ½ grm. of ore, treated with 20 c.c. of water mixed with 10 to 15 c.c. of hydrochloric acid. The whole is gently heated in a porcelain capsule, and when the liquid is on the point of boiling from 0·5 to 1 grm. of potassium chlorate in powder is added by small portions. When the action is over 50 c.c. of water are added to the liquid, and it is boiled afresh until the odour of chlorine is no longer perceptible. At this moment 20 to 30 c.c. of a saturated solution of ammonium sulphite are added, boiling again for a few minutes; the capsule is then withdrawn from the fire, and let settle. Care must be taken to supply the water which is lost by evaporation. The addition of the ammonium sulphite is to precipitate selenium and tellurium before electrolysing the liquid. After settling for half an hour the liquid is filtered, and the insoluble residue is washed. The volume of the filtrate should be about 200 c.c. This liquid is put in a glass beaker, and the electrodes are introduced. These are plates of metal; the one may be of platinum, but the other which communicates with the zinc pole of the battery must be of pure gold. The plates are suspended vertically in the liquid. The battery consists of two Bunsen elements. In twenty-four to thirty hours the operation is completed; the mercury is deposited upon the gold plate. The increase of weight in this corresponds to the quantity of mercury contained in the weight of metal taken.

Second Process. Direct Electrolysis of the Mercury Ore without previous Solution.—The ore, in fine powder, is placed in a platinum capsule, in a mixture of water, hydrochloric acid, and ammonium sulphite. For a 10 per cent ore the following proportions are employed:—Ore, 0·2 grm.; acid, 10 c.c.; water, 20 c.c.; sulphite, 20 c.c.; so as to make up about 120 c.c. These proportions are modified according to the richness of the ore. The platinum capsule (0·09 metre in diameter) is placed on a support, and a disc of gold of 0·04 metre in diameter is plunged into it; soldered to a rod of gold, communicating with the zinc pole of the battery, the capsule is connected to the other pole. In twenty-four hours the operation is

complete: the mercury is deposited upon the disc of gold, the increase of weight indicating the quantity of the metal.

In preference to a Bunsen battery, Don Luis de la Escosura uses six elements formed of a cylindrical vessel of glass, 0·10 metre in diameter and 0·16 metre in height, in which a zinc disc is suspended by means of two copper wires at two-thirds of the height of the glass above the bottom. At the centre of the zinc disc is a copper wire bent twice at right angles, so that the other extremity of the wire plunges into the glass vessel of the next element. To increase the surface of contact it is well to make the copper wire end in a spiral. The copper wire immersed in the liquid, except the spiral, is coated with an insulating substance.

The glass is filled with plain water after the crystals of copper sulphate have been introduced, and in a few hours the battery is ready for use.

This second process, though much simpler than the first, is strictly accurate, even in the case of very poor ores containing less than 0·1 per cent of mercury. The accompanying impurities do not interfere.—*Journal de Pharmacie et de Chemie.*

NOTICES OF BOOKS.

Cellulose: being a Short Account of the Chemical Properties of Typical Members of the Cellulose Group. with reference to their Natural History. By C. F. Cross and E. J. Bevan. Edited by W. R. Hodgkinson, Ph.D., F.R.S.E. London. Published for the Authors by G. Kenning.

This pamphlet summarises our present knowledge concerning cellulose, to which, as it is well known, the authors have made very important contributions, and it points the way for much important research.

For dissolving cellulose the authors recommend a modification of Schweitzer's reagent, prepared by mixing the substance to be operated upon with copper turnings in a tube contracted below and fitted with a stopcock. The ammonia is poured upon the mixture, drawn off, and returned repeatedly to the tube.

The fact is brought out that the mantles of certain mollusks—*Pyrosomidæ*, *Salpidæ*, and *Phalluria mamillaris*—contain a substance identical in composition and properties with the cellulose of plants.

The compounds of cellulose with oxides of nitrogen, usually viewed as nitro-celluloses, the authors consider as cellulose nitrates, since, unlike the nitro-compounds of other series, they do not yield amido-compounds on reduction with nascent hydrogen.

In representing the gun-cottons or pyroxilines, the authors, to avoid fractions, double the ordinary empirical formulæ. Hence true gun-cotton, the most explosive kind, quite insoluble in mixtures of ether and alcohol, is here described as a hexanitrate, whilst the collodion varieties become tetra- and tri-nitrates.

The two oxy-celluloses, α and β, are very fully described. The former, arising from the action of air, and light, or of bleaching-powder upon cellulose, is sometimes formed unintentionally in the process of bleaching vegetable tissues. It has an increased affinity for basic colouring-matters, and is coloured a bright yellow by warm solutions of phenyl-hydrazine salts. The authors notice its exceptional attraction for vanadium compounds, as combination ensues even when 1 part of the metal in the form of chloride dissolved in 1,000,000,000,000 parts of water is brought into contact with cellulose.

It is well known that man and probably the majority of the higher animals are unable to digest cellulose. The fluid from the vermiform appendage of the cœcum in the rabbit digests cellulose, evolving marsh-gas and forming a compound which reduces cupric oxide in alkaline solutions. The soluble ferment of the foxglove converts cellulose into glucose and dextrine.

The compound met with in jute fibre, which the authors formerly named bastose, they now include under the general heading Ligno-cellulose. They point out that the urine of the Herbivora normally contains hippuric acid or benzoyl glycocine, and the benzoyl-radicle required to form this body by reacting with the glycocine of the liver is a product of the digestion of ligno-cellulose, whilst the latter body contains no benzene compounds as such. Hence a portion of the complex ligno-cellulose molecule is in a potentially aromatic state. Coal itself, it is suggested, may be regarded as a pseudo-carbon derivative formed by a process of molecular condensation. The whole series of aromatic compounds may thus be traced back to a cellulosic origin.

There is very much more in this treatise to which attention might be called. In fact we have rarely had the good fortune to meet with so suggestive a work. The student of technology, of physiology, of organic chemistry as a scientific whole, will here meet with clues which, if duly followed up, will lead to the most important results.

CORRESPONDENCE.

THE DISCOVERY OF OXYGEN.

To the Editor of the Chemical News.

Sir,—Without doubting for a moment that Priestley discovered oxygen on August 1, 1774, I should be glad if you or some other historical chemist would enlighten me as to the following statement which I have culled from an old work on Chemistry:—

"Klaproth, "On the Knowledge of the Chemistry of the Chinese in the Eighth Century," infers that the Chinese were then acquainted with oxygen and the composition of water. The following is interesting:—

"'There are many circumstances purify it (referring to the atmosphere), and which can rob it of part of its *ȳne*; the chief of these are those things which are modifications of the *yânn*, such as the metals, sulphur (*lieôu-hhouânn*), and *tâne*, or carbon. These ingredients, when burnt, amalgamate the *yânn* of the air, and form with it new combinations of two fundamental bases. The *ky-ȳne*, or *ȳne* of the air, is always pure; but by the aid of fire it can be extracted from *tchine-chĕ* (a kind of whetstone), from *hhò-siaō* (nitre), and from *hhĕ-tânn-chĕ*, a black stone* found in the marshes. It enters also into the composition of water, in which it is so closely united with the *yânn* that its decomposition becomes extremely difficult. . . . Gold never amalgamates with the *ȳne* of the air, and is always found native.'"—*Mémoires de l'Académie Impériale des Sciences de St. Petersburgh*, tome ii., p. 476.

Most modern text-books on chemistry take us no further back than Priestley; so that if there be any truth in the above statement it is only fair that it should be noted. Possibly others beside myself may be interested in the matter.—I am, &c.,

Charles W. Duckworth.

Clayton, Manchester.
May 8, 1886.

FILTERING APPARATUS.

To the Editor of the Chemical News.

Sir,—The appearance in the current number of the Chemical News of matter relating to the Gooch filter

* Probably black oxide of manganese.

suggests the mention of an arrangement that I have had in use for some weeks. It consists shortly of the addition to the perforated platinum crucible of a thin external capsule of the same metal, about ⅜ inch deep. The capsule serves the double purpose of excluding reducing gases on ignition of a precipitate, whilst at the same time it collects any small particles that may perchance pass through the perforations. The capsule should fit somewhat tightly over the crucible, and is of course weighed with the latter prior to the collection of a precipitate. The internal diameter of the bottom of the crucible is that of a sixpence, and as a disc of paper whose ash is of almost inappreciable weight may often with advantage replace the asbestos felt the said sixpence serves as a guide for cutting the papers. When paper is used the small filter is easily brought to the upper part of the crucible and there consumed apart from the precipitate.

I may just add that the crucible, whilst the contents are drying and when ignited, is so inclined that the bottom of the capsule rests against one side of the triangle.—I am, &c.,

H.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 17, April 27, 1886.

On the Determination of the Organic Carbon contained in Soils which fix Free Nitrogen.—M. Berthelot.—To find the proportion of the organisms which fix atmospheric nitrogen in soils the author, finding their isolation impracticable, determines the carbon constituting their tissues. This is effected by combustion with copper oxide and afterwards with oxygen. In case of sands or clays he operates upon 30 grms. so as to collect about 100 m.grms. of carbon dioxide. For arable soils more rich in carbon a weight ten or fifteen times less is sufficient. The determination of organic hydrogen appears scarcely possible on account of the considerable proportion of water retained by soils dried at 100°, a point which cannot be safely exceeded for fear of altering the organic matter. The determination of the carbon presents a special difficulty on account of the carbonates present in arable soils, which are in part decomposed during combustion. The soils were therefore previously treated with an excess of hydrochloric acid, washed until the chlorides are removed, and dried in the water-bath. A portion of the organic carbon, however, is removed by dilute hydrochloric acid. It appears from the author's analyses that 1 kilo. of the soils which fix nitrogen contains from 1 to 2 grms. of organic matter, constituting the beings which effect the fixation.

Observations on the Proportion and the Determination of Ammonia in the Soil.—MM. Berthelot and André.—The authors observe that the losses of ammonia during the desiccation of soils, even in the cold, are considerable, especially with vegetable earth. The determination of the ammonia contained in soils must not only be effected by means of soda in the cold, but there should be no previous desiccation of the earth. The water must be determined separately in another portion. Soils moistened by rain or by watering tend continually to lose ammonia during their spontaneous drying in contact with air.

Nitrogenous Matters contained in Rain-Water.—MM. Berthelot and André.—It has been customary merely to determine the ammoniacal and the nitric nitrogen of rain-waters. The authors find it necessary to make further two determinations of organic nitrogen, the one in the atmospheric dust removed from rain-water by filtration, and the other in the filtered residue (previously evaporated to dryness) after determining the ammonia by Boussingault's method.

Rotatory Magnetic Power in Crystalline Bodies.—M. Chauvin.—The author remarks that in 1845 Faraday found all double refractive crystals inactive. Becquerel, Bertin, and Lutdge have since found this conclusion too general, and the author has now recognised a rotatory power even in Iceland spar.

Action of Alcoholic Potassa upon Urea, Sulphurea, and certain Substituted Ureas. Inverse Reaction to that of Wœhler.—Alb. Haller.—The author has studied the action of potassa upon urea, sulphurea, and certain substituted ureas. On cooling the tube was found lined with crystals of potassium cyanate. Hence these bodies, in an alcoholic medium, present a reaction the inverse of that by which their synthesis is effected.

Two Properties of the Urethanes of the Fatty Series.—G. Arth.—The author has previously shown that ethyl carbamate, on treatment with an alcoholic solution of potassa, yields potassium cyanate, alcohol, and water. The same reaction takes place with isobutylic, amylic, and caprylic ethers. All these, if treated in the same manner furnish an abundant precipitate of potassium cyanate with regeneration of the primitive alcohol. Octyle carbamate, prepared by the reaction of cyanogen chloride upon caprylic alcohol, yields on distillation at 230° to 232° a residue possessing the characters of cyanuric acid.

Abnormal Secretion of the Nitrogenous Matters of Yeasts and Moulds.—MM. Gayon and Dubourg.—The hypersecretion of nitrogenous matter under the influence of concentrated saline solutions is correlative to an increased production of soluble ferment.

No. 18, May 3, 1886.

On Magnetisation.—M. Mascart.—A mathematical paper, not susceptible of useful abridgment.

Formation of Oxalic Acid in Vegetation: Study of Rumex acetosa.—MM. Berthelot and André.—The authors propose to treat of the formation of oxalic acid in four selected plants, *Rumex acetosa*, *Chenopodium quinea*, *Amaranthus caudatus*, and *Mesembryanthemum crystallinum*. They confine themselves in this memoir to the *Rumex* alone.

Remarks on the Communication of MM. Berthelot and André relating to the Proportion and the Determination of Ammonia in Soils.—M. Schlœsing.—The author points out that he has not applied his process for determining ammonia to vegetable soils, and still less has he recommended the use of a concentrated solution of soda. The authors state that "arable earth, when moistened constantly, emits into the atmosphere the ammonia of the ammoniacal salts which it contains." In the opinion of M. Schlœsing the very opposite proposition is true.

Holmine (Soret's Earth X) contains at least Two Metallic Radicles.—Lecoq de Boisbaudran.—Will be inserted in full.

On Dysprosium.—Lecoq de Boisbaudran.—Will be inserted in full.

The Density of Atmospheric Air and its Components, and on the Atomic Volume of Oxygen and Nitrogen.—J. Wroblewski.—The density of oxygen at its critical point is 0·6; at −200°, under the pressure of 0·02 metre, it is 1·24. Its atomic volume is therefore 14, and not 16 as Dumas held. The density of nitrogen at its critical point is 0·44; at the moment of its solidification, 0·9. Its atomic volume is close upon 15·5. The density of liquid air at −146·6° and 45 atmospheres is 0·6.

The Combinations of Phosphoric Acid with Titanic Acid, Zirconia, and Stannic Acid.—MM. P. Hautefeuille and Margottet.—The phosphates of titanic acid, of zirconia, and of stannic acid have the atomic composition of silicium phosphate. If phosphoric acid is employed as a solvent they can only be obtained in the octahedral form, whilst silicium phosphate can be obtained not merely in this form, but in three others incompatible with the first.

Action of Vanadic Acid upon Ammoniacal Salts.—A. Ditte.—Ammoniacal salts may be divided into three groups according to their behaviour with vanadic acid. As instances of the first group the author gives ammonium phosphate, arseniate, molybdate, tungstate, iodate, and oxalate.

Studies on Butter.—E. Duclaux.—The constitution of the glycerides with volatile acids appear to be identical in all the butters examined.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 6, March 20, 1886.

Remarks on a Memoir by M. Schuppaus entitled "On the Action of Chloriue upon Boiling Benzol." J. Meunier.—M. Schuppaus in a recent memoir confirms the experimental facts on an "Isomer of Benzol Hexachloride," published by the author (*Soc. Chim.*, 1884, p. 530), save as concerns the optical properties of the crystals of this substance. The author found that these crystals have cubic forms, and that they are isotropic. M. Schuppaus, on the contrary, maintains that they are double refractive. A new examination made with a good polarising microscope proves that this substance, when really pure, has no action upon polarised light, whilst the ordinary hexachloride presents, under the same conditions, a series of the most brilliant tints.

Action of Acetic Acid upon French Oil of Turpentine.—MM. Bouchardat and Lafont.—Acetic acid combines even in the cold with oil of turpentine, forming monoacetates belonging to two quite distinct series, terebenthenic and terpilenic, whilst the uncombined oil is transformed into two carbides, $C_{20}H_{16}$, the one monovalent, analogous to terebenthene, and the second bivalent, an active terpilene.

Syntheses of an Active Terpilenol and two Active Camphenols by means of Oil of Turpentine.—G. Bouchardat and J. Lafont.—Oil of turpentine on treatment with acetic acid yields, besides terpilene, the two series of acetates corresponding to this terpilene and to terebenthene, and the hydrates of the same formula, but equally belonging to the two isomeric series.

Origin of the Ammonia-Soda Process.—L. Mond.—From the *Journal of the Society of Chemical Industry.*

Observations on Mr. Mond's Paper concerning the Origin of the Ammonia Process.—M. Scheurer-Kestner.—A supplement to the foregoing paper.

Application of Oxycellulose to the Determination of Vanadium.—G. Witz and F. Osmond.—The authors prepare slips of calico partially converted into oxycellulose, and immerse them in baths containing a solution of the substance in which vanadium is to be detected or determined, and for comparison in other baths containing known proportions of vanadium. They are then printed with the ordinary mixture for aniline blacks, minus the hypovanadium chloride. The blacks are then developed in the oxidation chamber and compared.

Action of Acid Ammonium Oxalate upon the Solubility of the Neutral Oxalate.—R. Engel.—The quantity of one of the oxalates in solution diminishes as the other increases. If a saturated solution of neutral ammonium oxalate is treated with a little oxalic acid there is not a precipitate of the acid salt, as it is generally supposed, but of the neutral salts. If the quantity of oxalic acid is increased a mixture of both salts is deposited.

Influence of Neutral Potassium Oxalate upon the Solubility of the Acid Oxalate.—R. Engel.—The solubility in water of acid potassium oxalate can only be known approximately. If an excess of the acid oxalate is placed in water it is partially dissociated into quadroxalate, a part of which is deposited, and into neutral oxalate, which remains in solution.

Reagent for Detecting the Acid Function of Weak Acids and Congeneric Functions.—R. Engel.—Already noticed.

On Amyl Monochlor-acetate.—L. Henry.—This compound is a colourless mobile liquid having a fruity odour like that of amyl acetate. It is almost insoluble in water, to which, however, it communicates its agreeable odour. Its density at 0° is 1·063; the boiling-point under the pressure of 751·5 m.m. is 190°.

Process for the Preparation of Phosphoric Acid.—A. Joly.—The ammonia of ammonium phosphate may be easily destroyed with *aqua regia*. It is possible to diminish the quantity of ammonia to be destroyed by taking advantage of the almost complete displacement of ammonia by means of hydrochloric acid in presence of phosphoric acid, and the relative insolubility of ammonium chloride in strong hydrochloric acid.

Volatile Products of Wines and Equation of the Fermentation of Sugars by Mycoderma cerevisiæ and M. ellipsoideus.—Ch. Ordonneau.—Already noticed.

On Dioxyethyl-methylene.—L. Henry.—The author admits the priority of M. Greene, who detected and described this compound as far back as 1879.

MEETINGS FOR THE WEEK.

Monday, 24th.—Society of Arts, 8. (Cantor Lectures). "Animal Mechanics," by Dr. B. W. Richardson, F.R.S.
Tuesday, 25th.—Institution of Civil Engineers, 8. (Anniversary).
—— Royal Medical and Chirurgical, 8.30.
—— Society of Arts, 8. "Cyprus since the British Occupation," by G. Gordon Hake.
—— Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
Wednesday, 26th.—Geological, 8.
Thursday, 27th.—Royal, 4.30.
—— Philosophical Club, 6.30.
—— Royal Institution, 3. "Habit as a Factor in Human Morphology," by Prof. A. Macalister, F.R.S.
Friday, 28th.—Royal Institution, 9. "Electrical Deposition of Dust and Smoke," by Prof. O. Lodge.
—— Quekett Club, 8.
Saturday, 29th.—Royal Institution, 3. "Light, with special reference to Effects resulting from its Action on various substances," by Prof. Stokes, Pres.R.S.

TENDERS FOR TAR.

The Corporation of Walsall are ready to receive Tenders from persons willing to purchase the surplus Tar made at their Old and New Gas Works during one year from the 1st July next.

The Corporation will deliver it into the Contractor's boats at the Gas Works. Not more than two boat loads will be allowed to remain in the tanks at each Gas Works at any time. The price per quantity of 210 gallons to be stated. To be paid for monthly.

Tenders, sealed and marked outside "Tender for Tar," are to be sent to me on or before Saturday, the 29th May instant.

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JOHN R. COOPER, Town Clerk.

Borough Offices, Walsall,
13th May, 1886.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1383.

ELECTROLYTIC CONDUCTION IN RELATION TO MOLECULAR COMPOSITION, VALENCY, AND THE NATURE OF CHEMICAL CHANGE:

Being an Attempt to apply a Theory of "Residual Affinity."*

By HENRY E. ARMSTRONG Ph.D., F.R.S.

(Concluded from p. 243.)

Valency—Chemical Change.

Notwithstanding the fierce controversy which has been waged between the advocates of the doctrine of fixed valency and the advocates of the doctrine of varying valency, our views on the subject are still in an unfortunate degreee unsatisfactory and indefinite. Even those—and they probably form a large majority—who regard valency as variable, dependent both upon the nature of the associated radicles and the conditions—especially as to temperature—under which these are placed, often hesitate to attribute a valency sufficiently high to account for every case of combination; in fact, both parties agree in distinguishing "atomic" from "molecular" compounds, and differ only as to where the line shall be drawn.

It is difficult to over-estimate the importance of the theory of valency: its application has led to an enormous extension of our knowledge of carbon compounds especially, and it has furnished us with a simple and consistent system of classifying the mighty host of these bodies; but, on the other hand, it may be questioned whether it has not led us away from the search into the nature of chemical change, and even if the introduction of the terms saturated and unsaturated has not had a directly pernicious effect. The almost universal disregard of molecular composition as an important factor in chemical change in the case of solids and liquids, and the popular tendency to overlook the fact that our formulæ of such bodies are purely empirical expressions, has undoubtedly exercised a prejudicial influence.

No known compounds *are saturated*—if any were, such would be incapable, I imagine, of directly taking part in any interaction, and in their case decomposition would necessarily be a precedent change. The paraffins are apparently of all bodies the most inert and the most nearly saturated, and next to them comes hydrogen—the unsaturated character of which is displayed in interactions such as occur at atmospheric temperatures between it and platinum and palladium, and when it displaces silver from silver nitrate or certain of the platinum metals from their salts. One of the most striking instances perhaps of popular error in this respect is water, which is always regarded as a saturated compound, although its entire behaviour and especially its physical properties characterise the molecule H_2O, I think, as that of an eminently unsaturated compound: I fail to see how otherwise we are to explain the high surface tension and high specific heat of liquid water, its high heat of vaporisation, and its imperfectly gaseous behaviour up to temperatures considerably above its boiling-point, let alone its great solvent power and its tendency to form hydrates with a multitude of compounds—*especially oxygenated* compounds, be it added.

The theory was brought most prominently under the notice of chemists by Helmholtz in the last Faraday lecture that electricity, like matter, is as it were atomic, and that each unit of affinity or valency in our compounds is associated with an equivalent of electricity—positive or negative; that the atoms cling to their electric charges, and that these charges cling to each other. Thus barely stated this theory does not appear to take into account the fact that the *fundamental* molecules even of so-called atomic compounds *are never saturated*, but more or less readily unite with other molecules to form molecular compounds—molecular aggregates; and unless the application of the theory to explain the existence of such compounds can be made clear, chemists must, I think, decline to accept it.* There is, however, a most significant passage in Helmholtz's paper, in which it is pointed out that (in a Daniell's cell) the phenomena are the same as if equivalents of positive and negative electricity were attracted by different atoms, and perhaps also by the different values of affinity belonging to the same atom, with different force: are we to seek for an explanation in this direction? The impression which the facts make upon the mind of the chemist certainly is, 1, that no two different atoms have equivalent affinities; and, 2, that affinity is a variable depending on the nature of the associated elements; but owing to the recognised complexity of nearly all cases of chemical change, it is difficult to draw any very definite conclusion on this point.

If, however, the nature and properties of so-called molecular compounds generally be considered, and if an attempt be made to form any conception of their constitution, one striking fact is noticeable, viz., that the *metals* in them apparently retain the properties which they exhibited in the parent atomic compounds. Every one knows the marked difference in properties of ferrous as contrasted with ferric salts: they differ not only in chemical behaviour, but also in their physical properties, and are readily distinguishable by their colour. The properties of the ferrous molecular compounds, however, are those of the simple ferrous compounds: ferrous potassium chloride, for example, $Fe_2Cl_4.Cl_2K_2$, is a green salt much like ferrous sulphate. Facts such as these have led me to suggest that in such cases the formation of the molecular compound is due to the attraction of the negative element of the one "atomic" compound by the negative element of the other, the metal having no influence except that the amount of affinity of which the negative element is possessed depends on the nature of the metal with which it is associated. It would in fact appear that hydrogen and the metals generally may be regarded as the analogues of the C_nH_{2n+1} and C_nH_{2n-7} hydrocarbon radicles, and that their compounds with negative elements may be likened to unsaturated hydrocarbons of the form—

$$C_nH_{2n+1}.CH.CH_2.$$

We know that whenever such a compound enters into combination the C_nH_{2n+1} radicle takes no part in the change, combination of whatever kind being effected by means of the unsaturated radicle $CH.CH_2$ with which it is associated. I do not mean to contend that the metals are fully neutralised in their compounds, but merely that as a rule they behave as though they were saturated just as do the C_nH_{2n-7} radicles derived from the benzenes. There can be little doubt that an absolute distinction must be drawn between hydrogen and the metals on the one hand, and the non-metals on the other. Regarding the facts in the light of our knowledge of carbon com-

* A Paper read before the Royal Society, March 25th, 1886.

* It is noteworthy that Clerk Maxwell ("Electricity and Magnetism," 1873, vol. i., p. 313), when speaking of the theory of molecular charges, says, "This theory of molecular charges—he uses the expression molecular in the sense that the chemist uses the term atomic—may serve as a method by which we may remember a good many facts about electrolysis. It is extremely improbable that when we come to understand the true nature of electrolysis we shall retain in any form the theory of molecular charges, for then we shall have obtained a secure basis on which to form a true theory of electric currents, and so become independent of these provisional theories." And later (p. 315): "While electrolysis fully establishes the close relationship between electrical phenomena and those of chemical combination, the fact that every chemical compound is not an electrolyte shows that chemical combination is a process of a higher order of complexity than any purely electrical phenomenon."

pounds, it is difficult to resist the conclusion that the differences observed are due to differences in structure of the stuffs of which the elements as we know them are composed, the which differences condition perhaps a different distribution of the electric charge or its equivalent in the case of each element.

In the earlier part of this paper I have ascribed the influence which the one set of molecules of the composite electrolyte exercise upon the other during electrolysis to the existence of "residual affinity." I believe this view also to apply to the explanation of the occurrence of chemical change. To quote the words of Arrhenius, "L'activité électrolytique se confonde avec l'activité chimique." Several pregnant examples of this have already been given by Ostwald (*Z. Pr. Chem.*, 1884, 30, 93).

The investigation of the nature of chemical change has assumed an altogether different aspect since the publication of Mr. H. B. Dixon's inquiry into the conditions of chemical change in gases (*Phil. Trans.*, 1884, 617; see also *Chem. Soc. Trans.*, 1886, 94). Mr. Dixon has clearly proved that it is impossible to explode a mixture of carbonic oxide and oxygen, and that the change—

$$2CO+O_2=2CO_2$$

is effected when sparks are passed across the tube containing the gaseous mixture *only in the path of the discharge*. If traces of water be present *explosion* takes place, the velocity of propagation of the explosive wave increasing with the amount of water up to a certain maximum. These results completely dispose of the popular explanation of such changes, viz., that the molecules in the path of the discharge undergo *dissociation*, that the dissimilar atoms thus liberated then combine together, and that as the heat developed in their union causes the dissociation of yet other molecules, change gradually extends throughout the mass.* Mr. Dixon's experiments have not only shown that the propagation of change is dependent on the presence of a third body, but that this third body must bear a certain relation to those with which it is associated: CO_2, CS_2, C_2N_2, CCl_4, SO_2, and N_2O were found by him to have no action, and only water—or bodies which formed water under the conditions of the experiment—were found capable of determining the explosion, and there is an obvious difference in constitution between water and the bodies found incapable of determining explosion: the former being a compound of a positive with a negative element, the latter being all compounds of two negative elements. If it be permissible to generalise from this single instance, it may hence be stated, that in order that interaction shall take place in cases such as that under consideration, it is not only necessary that the elements of the "catalyst" shall be *divisible*† between the interacting substances—the elements of CO_2 are obviously as divisible between CO and O_2 as are those of H_2O—but that the catalyst shall consist of a positive and a negative and not of two negative radicles. On this view, it is possible to understand that water itself may act as the catalyst in determining the formation of water at high temperatures from hydrogen and oxygen.‡

In the case discussed (the oxidation of carbon monoxide) interaction takes place at a very high temperature, and therefore—since high temperature may be regarded as the equivalent of high electromotive force—under conditions under which the catalyst water is probably a simple electrolyte. The behaviour of sulphur dioxide in presence of oxygen and water is instructive as being a case of an analogous interaction occurring at a low temperature. From a most carefully conducted series of experiments by Mr. Dixon (*Journ. of Gas Lighting*, 1881, 37, 704) it appears that not only does sulphur dioxide not undergo change in contact with dry oxygen, but that it even resists oxidation if water vapour be present, and at a temperature of 100°; as is well known, however, oxidation takes place—but only *slowly*—when an aqueous solution of sulphur dioxide is in contact with oxygen. In this case, in the gaseous mixture the water apparently is not under such conditions that it can act as a simple electrolyte or even form a composite electrolyte, and action only takes place when the conditions become such that a composite electrolyte can be formed; Ostwald's observations may be held to prove, I imagine, that a very imperfect composite electrolyte results on dissolving sulphur dioxide in water, and in accordance with this is the fact that the aqueous solution is but *slowly* oxidised.*

If a clear distinction can be drawn—as I suppose it can—between simple and composite electrolytes, the presence of a member of the latter class will probably be found to be essential to the occurrence of many interactions taking place at moderate temperatures; thus the oxidation of iron, which is generally supposed to take place only in moist air, is doubtless dependent, not merely on the presence of *water*, but of *impure* water—of water rendered conducting by association with foreign matters; similarly it may be expected that zinc will be found to have no action on water even when associated with a less positive metal, and it would doubtless have no action on sulphuric acid if such a compound were obtainable in a pure state; but a mixture of sulphuric acid and water readily dissolves it, as the two together form a composite electrolyte of comparatively low resistance.

It can scarcely be doubted that when our elements or compounds are resolved into their ultimate atoms, these atoms are capable of *directly* uniting, and that no catalyst is then required. But if this be the case, and if, as I suppose, the atoms rarely *saturate* each other, the *direct* union of compounds should also be possible in cases in which there is considerable residual affinity; such union would not involve a separation from each other of the constituent elements of one or both of the interacting bodies such as takes place in the changes previously considered. Union of two molecules having taken place, the elements of the interacting bodies having thus been brought into intimate association, it is very probable that in many cases intramolecular change will then supervene, resulting sometimes in mere atomic redistribution, at other times in the resolution of the complex molecule into simpler molecules. I am inclined to think that the majority of so-called double decompositions are thus brought about.

The union of sulphuric anhydride with water to form sulphuric acid, and of sulphuric acid with water to form hydrates, are doubtless cases of this kind. The formation of the hydrate $SO_3.OH_2$ must be supposed to be immediately followed by the occurrence of atomic redistribution if we accept the current view that sulphuric acid is a hydroxide of the formula $SO_2(OH)_2$; whether after the formation of the hydrate $H_2SO_4.OH_2$ has taken place atomic redistribution in like manner supervenes is a moot point; the large amount of heat developed by the interaction of water and sulphuric acid is, however, specially noteworthy.

Sodium hydroxide is universally regarded as the analogue of water: is its action on sulphuric acid analogous

* I am not to be understood to imply that dissociation does not take place in the path of the discharge; on the contrary, for all the facts appear to me to indicate that conduction and electrolysis are inseparable phenomena in gases as in liquids (comp. Schuster, *Proc. Roy. Soc.*, 1884, 317).

† Mr. Dixon's experiments appear to prove that during the interaction of carbonic oxide and oxygen in presence of water an actual division of the elements of the water molecules takes place between the carbonic oxide and oxygen molecules, and hence that the water does not exercise a mere contact action.

‡ When this question first came under discussion at the Chemical Society I said that I looked forward to the time when probably it would be found that a mixture of pure hydrogen and oxygen was inexplosive, like one of pure carbonic oxide and oxygen. I was then still under the influence of current opinion and regarded water as a saturated compound, and had not yet realised the important function of "residual affinity" in such changes.

* The behaviour here described of sulphur dioxide appears to me to furnish another argument adverse to the dissociation hypothesis, as oxidation takes place under the conditions least favourable to the occurrence of dissociation.

to that of water? I certainly am inclined to hold that it is, and that in the first instance an aggregate,—

$$NaHO.SO_4H_2,$$

results, owing to the attraction of the oxygen of the hydroxide by the oxygenated radicle of the acid: atomic redistribution thereupon takes place, and either the molecule is resolved into two others, water and sodium hydrogen sulphate, or a new compound is formed which is easily resolvable into these latter. Moreover, I am inclined to attribute this change and the consequent displacement of the hydrogen in the acid by the sodium, not to the fact that sodium has a greater affinity than hydrogen has for SO_4, but to the tendency of hydrogen to displace the sodium in sodium hydroxide and to form water. I do not contend that in such a case as that quoted direct interaction will take place between the substances as we know them in the solid state; these may consist of comparatively inert complex aggregates which require to be resolved into simpler molecules either by dissolution or by application of heat. In other words, the presence of water may be necessary, not because it is essential to have an electrolyte present, but because the occurrence of both molecular interaction and electrolytic conduction depends on identical molecular and intermolecular conditions. The chemical interaction takes place entirely independently of the water molecules, and these latter serve only to separate and keep apart the fundamental molecules of which the interacting bodies are composed.

No final decision for or against the view here put forward can well be arrived at except by the study of the behaviour of gaseous bodies such as ammonia and hydrogen chloride, for example; if proof can be given that these compounds are capable of directly uniting without the intervention of any third body, a most important step will have been made.

Other cases deserving of study are the conversion of nitric oxide into nitric peroxide, oxidation by means of ozone, and the action of metals such as sodium on water. As the formation of nitric peroxide involves the prior separation of oxygen-atoms from oxygen-atoms, and not merely the combination of two molecules, it is not improbable that interaction between nitric oxide and oxygen molecules will only take place in the presence of a catalyst. But it is to be borne in mind that both nitric oxide and ozone are bodies which are capable of interacting with molecules of their own kind, and that considerable heat is thereby developed; and it is conceivable that such bodies being possessed of high residual affinity may directly enter into combination with others which have but little residual affinity. As regards the action of sodium on water, the difference in behaviour with dilute sulphuric acid between moderately pure zinc and very nearly pure zinc is so marked that the vigorous action between sodium and water cannot be held to prove much, as no special care is ever taken to prepare sodium pure; the question whether the affinity of the oxygen in water for sodium is sufficient to cause their direct association and consequent interaction is an interesting one for experimental inquiry, although it would be very difficult to make the experiment properly.

One other application of the theory dwelt on in this paper remains to be mentioned. It is now well established that on exploding gaseous mixtures within a closed chamber the maximum theoretical temperature is never reached; and this has hitherto always been explained as due to the occurrence of dissociation, whereby the change is retarded. If in a mixture say, of carbonic oxide, oxygen, and water gases the three kinds of molecules act together in the manner I have supposed, it is probable that the extent to which they mutually influence each other would vary with the temperature, and that it would tend to diminish above a certain temperature; if such were the case, change would be retarded in the manner in which it appears to be in explosions within closed chambers. Dissociation undoubtedly does take place in many cases, but there is now a considerable amount of evidence on record to show that the bounding surfaces exercise a most important influence; this is usually not sufficiently taken into account.

RESEARCHES ON THE VITALITY OF THE SPORES OF PARASITIC FUNGI, AND THE ANTISEPTIC PROPERTIES OF FERROUS SULPHATE.*

By Dr. A. B. GRIFFITHS, F.R.S. (Edin.), F.C.S. (Lond. and Par.)[1]
Lecturer on Chemistry, Technical School, Manchester,
Examiner in Chemistry, Blairlodge School, Polmont, N.B., &c.

FERMENTS and microscopic fungi are certainly inconspicuous organisms, but they cause us an untold and untellable amount of trouble, vexation, and loss, not to mention the pain, misery, and death which these low forms of life produce when they find entrance into the system either of an animal or man himself. Their small dimensions, their invisibly minute organs, their ever-present germs floating about in the air and carried in the water until they find surrounding circumstances and a suitable medium in which they can live their life-histories —all combine to render us helpless to a certain extent in our strife and struggle with them.

I have already had the honour of presenting to the Royal Society of Edinburgh a paper "On the Antiseptic Properties of Salicylic Acid,"† on the "disease ferments" which produce after changes in saccharine liquors, like beers, wines, &c. In this paper I wish to detail some researches on the use of iron sulphate as an antiseptic agent in connection with parasitic fungi which attack our crops; also the length of time spores of fungi are capable of existing in a dry state in the atmosphere.

It will be remembered that I have advocated the use of iron sulphate as a manure for some four or five years. My memoirs on the subject are to be found in the *Journal of the Chemical Society* and the CHEMICAL NEWS (1882-6). These investigations have also been repeated by others with similar results.‡ But, beyond being simply a plant-food, iron sulphate has antiseptic properties which I have already shown is sufficient to destroy certain low forms of plant-life (CHEMICAL NEWS, vol. xlix., p. 279 [1884], and *Journal of the Chemical Society*, 1886, p. 119), yet at the same time largely increasing the yield of agricultural crops generally.

Concerning the vitality of certain spores of fungi, I have experimented in the following manner:—A quantity of spores of *Peronospora infestans* (potato-disease) were taken from a crop of diseased potatoes. These spores were then placed in a porcelain mortar along with about 5 grms. of a mixture of calcium sulphate and calcium carbonate, which were thoroughly mixed together. This mixture was then placed in a small oven always kept at a temperature of 35° C. (dry heat). After the spores had been dried up with these mineral substances (which principally constitute the dust found in the atmosphere) for two months, they had not lost their vitality, for in the space of three days after "sowing" they began to penetrate into the mesophyll of the leaves (of a potato plant) through the stomata. The leaves of *Solanum tuberosum*, along with dried two-months' old spores of *Peronospora*, were kept in a warm moist atmosphere, such conditions being favourable for the development of these spores. On

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* Read before the Royal Society of Edinburgh May 17th, 1886.

† CHEMICAL NEWS, vol. liii., p. 28; *Chem. Soc. Journ.*, 1886, p. 386; and *Proc. R. S. E.*, No. 121.

‡ See Dr. Munro's paper, CHEMICAL NEWS, vol. liii., pp. 2 and 3; also *Journal of the Chemical Society*, 1886, p. 389.

the fifth day after "sowing" there was a mycelium which had ramified through the tissues of the leaf, and I also observed the production of conidia-bearing branches making their appearance through the stomata of the leaves. After *six* months of dry heat another portion of the dust was examined under the microscope, mounted in water as before. The cellulose wall of the spores appeared rather shrivelled. Their vitality had not disappeared, for after seven days from "sowing" on the potato-leaf there was a rapid development of hyphæ, mycelium, &c.; thus showing that, even after the spores had been dried up for six months as dust, they were capable of germinating, and each organism leaving its life-history upon the host plant.

Again, after being in a dried state for ten months, it was found that the spores had lost their vitality. They did not germinate upon the leaves of *Solanum*, not after being in contact with the leaves in a damp and warm atmosphere for a month or six weeks. Under the microscope the spores were seen to be shrivelled up and their protoplasm dead.

From this investigation it will be seen that the spores of *Peranospora infestans* may be dried up in an atmosphere and preserved as dust for the space of eight months without the loss of their vitality, and will germinate again when favourable circumstances are offered for their development.

The next point we come to is a study of the action of a solution of iron sulphate ($FeSO_4$) upon certain parasitic fungi. An aqueous solution containing as little as 0·1 grm. of iron sulphate in 100 grms. of water was found to have the power of destroying the *Peronospora infestans* (potato-disease). I cultivated a good crop of *Peronospora* on the cut surface of the tubers of diseased potatoes, in a warm damp atmosphere, under a bell-glass. Also the leaves of *Solanum tuberosum* were placed under the same bell-glass. The spores of the fungus easily threw out hyphæ which penetrated the tissues of the leaves. By taking a portion of the fungus and its spores (conidia) by the point of a needle, and placing them upon a microscopic slide, mounting them in a drop of water, then running in between the slide and cover-slip the above-named solution of iron sulphate, it was observed that the cellulose wall of the hyphæ and of the spores of *Peronospora* were perforated in all directions.

It appears that iron sulphate acts upon the cellulose, or the form of cellulose, making up the external wall of this lowly organism and its spores.

Iodine and sulphuric acid do *not* colour the cellulose walls of this fungus a blue colour, whereas it is a well-known fact that the cellulose of the higher plants is coloured by iodine and sulphuric acid.

I have also found that the iron sulphate solution does *not* attack the cellulose wall of the higher forms of plant-life, nor even when we get so low in the scale as the Zygnemaceæ (fresh-water Algæ), for the iron sulphate solution made no impression upon the cellulose walls of *Spirogyra*.

It is most probable that the cellulose of parasitic fungi is different in its atomic structure from the cellulose of the higher plants. It is most likely an isomeric modification of ordinary cellulose.

In passing I may state that Dr. H. Müller (*Biedermann's Centralblatt für Agricultur-Chemie*, 1883, pp. 630 to 637) recommends the use of a solution of iron sulphate (1 part of $FeSO_4$ in 2 parts of water) for washing vines, as an antiseptic against the vine-mildew. No doubt the action of iron sulphate upon the vine-mildew is the same as I have already described concerning *Peronospora infestans*.

I have found that lactic acid is always formed in small quantities in diseased potato-crops; not only in the tubers, but in the leaves of the potato-plant during life. It may be that during a damp warm summer, which is always favourable for the development and growth of parasitic fungi, that a portion of the starch in the tubers of the potato-plant becomes hydrated,—that is, converted into one of the members of the glucose family of carbohydrates, this glucose being most likely decomposed by the growth of *Peronospora* into lactic acid:—

$$C_6H_{12}O_6 = 2C_3H_6O_3.$$

Concerning the lactic acid found in the leaves of *Solanum tuberosum* during disease, we know, from the researches of Sachs and others, that starch is one of the first products of assimilation in the chlorophyll cells. This starch is subsequently transferred to other cells by the process of metastasis; but before it is transferred it is converted from the insoluble (starch) to a soluble form,—viz., glucose sugar,—which may account for the presence of lactic acid in diseased leaves of *Solanum*, as described above.

It has been ascertained by the veteran chemist M. Chevreul (Hon. F.R.S.E.) that fungi (like the mushroom) *greatly flourish* when watered with a weak solution of potassium nitrate. From this fact the question may be raised, How far have *potash* manures in damp seasons helped to foster the development and growth of parasitic fungi? At any rate the true potato-disease appeared about the year 1830, and this was about the time artificial manures were first applied to our lands, for it was found that farm-yard manure was incapable of returning all the mineral constituents to the soil which had been extracted by the growing crops. This fact was well established by the experimental investigations of Schubert, Saussaure, and particularly to the researches and philosophy of Liebig.*

Concerning the potato-plant it appears, from De Candolle, that it is a native of Chili, was first introduced into Europe by the Spaniards† about 1580, and a little later into England. For nearly 250 years no signs of disease appeared in the crops of cultivated potatoes. Hence it may be that *potash* manures have rather aided the development and growth of the *Peronospora infestans*, in damp warm seasons, than otherwise. I am fully aware that M. Déhérain has shown that in certain plants starch is *not* generated by chlorophyll unless *potash* is in the soil. (If potash salts are added, then starch begins to be formed in the chlorophyll granules). Potash manures appear to be not only one of the necessary mineral foods of *Solanum tuberosum*, but also for its parasitic fungus.

No doubt the potato fungus existed centuries ago on the wild potato-plants of South America. On the introduction of the plant into Europe the circumstances and surroundings (as far as climatic conditions are concerned) were changed, not only for the potato-plant itself, but also for its parasite. Hence it may be that, on the introduction of potash manures, these plant-foods revived the dormant vitality of *Peronospora infestans* to its natural activity, giving rise to the frightful ravages which this fungus produced in our potato-crops from fifty or sixty years ago, and have never since entirely disappeared.

As we have seen, the spores of *Peronospora* are capable of being dried up with dust for a considerable time without losing their vitality (the same remark applies to the spores of wheat-mildew and other fungoid growths). I recommend the use of a weak solution of iron sulphate to water ordinary farm-yard manure before it is applied to the land. Farm-yard manure may contain spores from the wheat-straw, &c., forming the litter in the farm-yard. These and other spores hybernate until the Spring (farm-yard manure being a medium that rather favours this dormant state than otherwise), and are then ready to live their life-history again, the infested farm-yard manure being a material which is capable of inoculating the cultivator's newly set seed-potatoes, &c. Again, it may be that the seeds (wheat for instance) contain these minute spores of disease which are always more or less in the atmosphere during the summer months. The farmer has

* "The fertility of a soil cannot remain unimpaired unless we replace in it all those substances of which it has been thus deprived." —(Liebig's "Organic Chemistry in its Application to Agriculture and Physiology," p. 174.)

† See Clos' "Quelques Documents sur l'Histoire de la Pomme de Terre," *Journal d'Agric. Pratiq. du Midi de la France*, 1874.

a remedy, namely, by steeping his seeds before "setting" in a solution of ferrous sulphate, for the spores are all destroyed by this mineral substance, and the seed is not injured in the least.

We now come to consider the action of iron sulphate upon another parasitic fungus, namely, the "wheat-mildew," in both stages of its life-history. First, with the red spores ("rust") of the barberry fungus, which produce hyphæ and a mycelium in the cells of the stem or leaf of a wheat-plant or similar cereals, and also with the two-celled spore (teleutospores) of the wheat-mildew, which germinate on the leaf of the barberry. I have *not* ascertained to what length of time the two kinds of spores of this dimorphic fungus are capable of retaining their vitality or power of "germination." At any rate it may be as long as that of *Peronospora infestans*.

On placing the *Œcidium* spores, uredospores, and teleutospores on slides under the microscope (mounted in water), and on running in between the cover-slips the solution of iron sulphate (0·1 grm. in 100 grms. of water), the different kinds of spores are completely destroyed. Not only the spores, but the hyphæ which give rise to mycelia within the stem and leaves of *Triticum vulgare* (wheat-plant), are completely destroyed, the cellulose walls being perforated by this antiseptic agent, while the cellulose walls of the epidermis of the wheat-plant (through which teleutospores and uredospores make their appearance) are not "touched" in the least by this solution.

In diseased wheat-crops I have found small quantities of alcohol, and also acids, but not in healthy crops. These bodies may be due to the decomposition of glucose sugar, which is always in the sap of the cells. Hence it appears that parasitic fungi may cause the abnormal development of compounds within the living cells of the host plant, and so poison its various parts. I have obtained, on watering healthy potato-plants (roots, and also the leaves) with a solution of *lactic acid*, shrivelled leaves and "brown spots," something like the appearance when the plant is infested by *Peronospora*. I am inclined to think that the poisonous products formed by *Peronospora* are the immediate cause of the unhealthy condition of potato-crops at certain times. The same remark applies to other parasitic fungi which attack our crops.

My friend Mr. G. W. Edgson, of Etton, Peterborough (an agriculturist of great experience), has found that wheat-crops manured with iron sulphate completely resist the attacks of wheat-mildew (*Chemical Society Journal, Trans.*, 1886, p. 116).

Hence it will be seen that iron sulphate is a valuable agent in the hands of the agriculturist, not only as a manure, but as a remedy against the attacks of that "unseen mist of organic forms."

It will also be observed that the solution of iron sulphate used in my microscopical studies perforates the cellulose walls of the cell of parasitic fungi, and not the cellulose walls of the higher plants. This points to a constitutional difference in the atomic structure of this form of cellulose,—that is, it is an isomer of ordinary cellulose.

I may allude, in passing, that (to a certain extent) a difference was observed in the structure of fungi from the higher forms of plant-life by the father of physiological botany, Dr. Grew, F.R.S., two hundred years ago, for he says*—"*Both the substance of the pipes and the other parts of the mushroon, so far as visible, is answerable only to the cortical or pithy part of a plant,—so that it seems to be but half of a perfect plant.*"

In conclusion, the "Golden Age," which Ovid speaks about in his "Metamorphosis" (Liber I.),—

> "Mox etiam fruges tellus inarata ferebat,
> Nec renovatus ager gravidis canebat aristis,"

has long passed away. The virgin soils of centuries ago have been used up, and new discoveries, which help the fertility of the soil and place in man's hand the means of destroying parasitic disease, are of national importance, especially to a country like our own, where there is great competition with foreign nations in agricultural produce: for this reason I tender my little mites of scientific work for the good of humanity.

I wish here to thank my friends (personal and scientific):—Sir Richard Owen, K.C.B., F.R.S.; Sir J. B. Lawes, Bart., F.R.S.; Prof. J. P. Cooke, LL.D. (Harvard University, U.S.A.); Prof. F. Guthrie, F.R.S.; Dr. A. C. Maybury, D.Sc., M.R.C.S; Dr. G. McGowan, F.R.S.E.; Mr. Johnstone (of Geneva); Mr. J. C. Wright, F.C.S. (of Ayr), and others, for their kind letters and suggestions concerning my agricultural researches.

* "Musæum Regalis Societatis," by Dr. Grew, F.R.S., 1681, p. 238.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 20th, 1886.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs Thomas Akitt, 25, Gascoyne Road, South Hackney, London; Alfred C. A. W. H. Chapman, 2, Queen Anne's Avenue, High Road, South Tottenham; Charles Alexr. Kohn, Redcliffe Villa, Redcliffe Road, Nottingham; John Temple Leon, 26, Belsize Park Gardens, N.W.; William Ray, Spenceley House, Victoria Road, Leeds; William Richards, 185, Isledon Road, Finsbury Park, London, N.; Joseph Price Remington, 1233, Walnut Street, Philadelphia, U.S.; William Saunders, London, Ontario, Canada; Charles A. Smith, The Laboratory, 8, Loftus Street, Sydney.

The following were duly elected Fellows of the Society:—Messrs. Edward Jennings Ball, Ph.D., Holland Crompton, Parvati Nath Datta, Robert Elliott Doran, Richard Dormer, Witham Dobinson Halliburton, George William Saul Howson, John Tysilio Johnson, A. Wentworth Jones, William Henry Pendlebury, William Selby Simpson, Henry H. Walker.

The PRESIDENT exhibited a specimen of the mineral Argyrodite—a sulphogermaniate of silver; also a number of specimens which he had recently received from Prof. Winkler of the new element Germanium and its derivatives. He said that, according to the information given to him, germanium was a silver-white, brittle, volatile metalloid of the relative density 5·46; its atomic weight is 72·75. It appears to be identical with Mendelejeff's *Ekasilicium*, for which the atomic weight predicted was 72 and the relative density 5·5. Germanium forms two sulphides—a yellow monosulphide, soluble in alkali, which readily volatilises, subliming in well-formed crystals somewhat like those of iodine in colour; and a white disulphide. It furnishes corresponding oxides: a liquid tetrachloride, boiling at 88°; and an orange-red, crystalline, volatile tetriodide.

With reference to the President's communication on the new element Germanium, discovered by Prof. Winkler, Mr. JOHN A. R. NEWLANDS begged leave to remind the Society that, in a paper in the CHEMICAL NEWS for July 30th, 1864, nearly twenty-two years ago, he had pointed out that an element was missing in the group comprising carbon, silicon, titanium, and tin, having an atomic weight of 73, being the same element which M. Mendelejeff had several years later predicted under the name of Ekasilicium.

The PRESIDENT remarked that they all knew that Mr. Newlands had done valuable work in the initiation of the Periodic Law, and he was fully justified in calling attention to the facts of the case on the present occasion.

Dr. SPRENGEL exhibited a series of specimens illustrating the effect produced on leaden cylinders by the explosion of equal weights (15 grms.) of nitroglycerine and of mixtures of half nitric peroxide and half (*a*) CS_2, (*b*) benzene, (*c*) nitrobenzene, (*d*) nitrotoluene. The effect produced by the nitroglycerine was very much less marked than that produced by any of the other explosives, of which those containing nitrobenzene and nitrotoluene were by far the most powerful.

The following papers were read :—

46. "*Sources of Error in the Calorimetric Study of Salts.*" By Prof. W. A. TILDEN, F.R.S.

Mr. Pickering has recently published, in the *Transactions of the Chemical Society*, a paper containing very numerous estimations of the heat of dissolution of various salts at temperatures ranging from near zero to about 25° C., and in the *Phil. Mag.* for March and April he has given an account of the precautions he has taken to avoid experimental error, or to make allowance for it.

In his principal paper (*Chem. Soc. Trans.*, May, 1886) he arrives at such extraordinary conclusions in regard to the behaviour of salts in act of dissolution in water, and at the same time protests so emphatically against the suspicion that the irregularities he has observed are due to experimental error, that, having been myself occupied with experiments in the same direction, I have been led to examine Mr. Pickering's paper very carefully.

The process of dissolving a solid in water in such a manner as to allow of the determination of the heat evolved or absorbed is one which is beset with difficulties. But these are not all of equal importance, some being so small as to produce little or no appreciable effect on the result; others, however, being of such a formidable character as to render such determinations extremely difficult and uncertain. Mr. Pickering claims that his results exhibit an extremely high and altogether exceptional degree of accuracy. Without this exceptional accuracy the conclusion which he deduces cannot be maintained. A critical examination of the numbers recorded in his tables of results shows that his experiments, though undoubtedly conducted with great care and skill, have not led to results of any very unusual accuracy, and in fact that there are in many cases great discrepancies in the results of duplicate experiments. Some of these discrepancies I attribute to a want of discrimination between the several sources of error in respect to their influence on the result.

Mr. Pickering has given great attention to the calibration and observation of his thermometers, even using instruments said to be capable of reading to 1-3000th of a degree C., but he has given no detailed account of his method of correcting for the cooling or heating by radiation or conduction of the calorimeter during the progress of the experiment, although this latter, as he admits, is by far the most serious source of error, and might lead to a difference a hundred times greater than that arising from ordinary errors in calibration or reading of thermometers. Again, it would doubtless be impossible in such experiments to ensure the accomplishment of the act of dissolution in the several experiments at any given temperature in equal times; and yet if this is not done an error is introduced which it is impossible to estimate by observation of the rate of cooling before or after the experiment.

However, it is not suggested that Mr. Pickering's results are less than usually accurate, but only that they do not reach that unassailable standard which alone would justify the conclusions he draws from them. The supposition that the heat of dissolution of a given salt in water at successively higher temperatures is represented by a succession of irregular curves is not supported by Mr. Pickering's own experimental numbers, but results from the unjustifiable employment of arithmetical means. When *all* the numbers given in the tables are plotted on curve paper the remarkable sinuosities pointed out by Mr. Pickering for the most part disappear. One does perceive, however, that the discrepancies among the individual results are so great as to preclude the possibility of drawing from them any conclusion whatever as to the exact form of the curve in the several cases.

DISCUSSION.

Mr. PICKERING said that no one could be more fully aware than he was himself that the irregularities which he had observed depended on differences but little larger than those due to experimental error. The whole difficulty of the investigation lay in this very fact. No one could have laboured more energetically than he himself had done to disprove these irregularities, and he only accepted them when their existence became undeniable. In his opinion it was distinctly a case in which the means from a large number of experiments, and not each individual determination should be considered. Taking the instances selected by Dr. Tilden, he contended that the irregularities could not be regarded as experimental error. In the case of potassium sulphate the heat of dissolution from 26·5° to 17° is represented by a straight line; from 11° down to 3° it is represented by another line at a different inclination from the first, but scarcely less straight. If the point at 14° is to lie in the first line the heat of dissolution there would be 6870 cals., if in the second line 6820 cals. Now of the eight determinations on which the observed depression at this point was based, the lowest was only 6908 cals.; the mean of four determinations with one thermometer gave 6941 cals., and of four other determinations with another thermometer 6963. By no possibility could Dr. Tilden manipulate those numbers so as to lower them even to 6870, and thus obliterate the depression which they represent. The only other means by which this could be done would be to admit an error of at least 82 cals. in the general results of all the other experiments—70 in number—at the other temperatures; a proposition quite inadmissible. Mr. Pickering professed himself ready to discuss in the same way the irregularities in any of the other curves. Dr. Tilden had specially alluded to the depression in the curve of $CuK_2(SO_4)_2{\cdot}6H_2O$, which was the one salt least fully examined of all: as Mr. Pickering had mentioned in his paper (p. 282), he would have paid but little attention to this depression were it not that there was subsidiary evidence that the point at which it occurs (14°) was a temperature at which the salt experienced some marked alteration. Looking at the curve representing the heat of combination of the salt with its water of crystallisation, it would be seen that this heat is represented by a straight line from 2° to 12° showing the rapid increase of 130 cals. per degree, while from 16° to 23° the heat of combination remains constant.

On the strength of there being but one determination with K_2SO_4 at 12·36, Dr. TILDEN accused him of having repeated experiments at the debatable points without having examined the points in its vicinity. This charge Mr. Pickering entirely denied. In the case in point Dr. Tilden would find, on a more careful examination, that within about 3° of the temperature where the depression was noticed (14°, there being eight experiments here) he had made no less than nineteen determinations. Again, the lowest point (13·14°) in the $MgSO_4{\cdot}7H_2O$ curve, at which there were seven determinations, was accompanied by nine determinations at other temperatures within 1·5° of it. It was certainly natural, and indeed indispensable, that any point at which an anomaly was noticed should be more fully examined than other normal points, but the repetition of such experiments was generally accompanied by the repetition of other experiments at points above and below it, though not *necessarily* very near to it; and as a further precaution these experiments at different temperatures were in many cases, and at the expense of immense labour, performed on the same day (p. 281).

Dr. TILDEN suggested that Mr. Pickering, while fully alive to the less important errors introduced by defects in the thermometers, might have overlooked the greater errors involved in determining the rate of cooling, and in

the manipulation generally. Dr. Tilden would, however, find that in a paper read before the Physical Society (*Phil. Mag.*, 1886, p. 324) he had discussed not the errors inherent in thermometers, as he did in two other papers (*ibid.*, 180, 330), but the errors of calorimetric work as illustrated by the actual results obtained in these very experiments themselves, results which had been influenced by, and would therefore afford a criterion of, the accumulated errors from all sources.

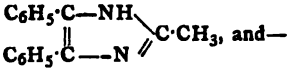
Mr. PICKERING then described his method of operation, and explained that the determination of the rate of cooling was far more simple in his experiments than those of Dr. Tilden; for the temperature of the air is always the same as that of the calorimeter, and the rate of cooling was thus reduced so far as to be constant for the whole duration of the experiment. Mr. Pickering had found that even where the dissolution of a salt was not completed within five minutes or more, the final temperature of the calorimetric water was practically attained within about half a minute: it was during this short space of one half minute only that the temperature, and therefore the cooling correction, was uncertain.

Dr. WRIGHT remarked that, according to his experience, the experimental error was much greater if the substances to be mixed were at the temperature of the air; the error due to radiation was much less if the temperature initially was as much below as it was finally above atmospheric temperature.

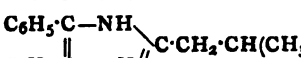
Prof. TILDEN, in reply, said that he thought that Mr. Pickering had failed to explain the discrepancies which he had pointed out.

47. "*On the Action of Aldehydes and Ammonia on Benzil.*" By FRANCIS R. JAPP, F.R.S., and W. PALMER WYNNE, B.Sc.

The compounds obtained with acetaldehyde and isovaleraldehyde are the glyoxalines—

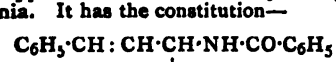


Methyldiphenylglyoxaline (m. p. 235°).



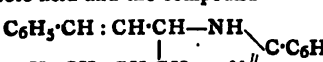
Isobutyldiphenylglyoxaline (m. p. 223°).

With cinnamaldehyde, benzil, and ammonia two reactions occur, two distinct compounds being formed, one of which is practically insoluble, the other moderately soluble, in boiling alcohol. The insoluble compound has the formula $C_{32}H_{28}N_2O_2$, and is an analogue of that obtained by Japp and Hooker from salicylaldehyde, benzil, and ammonia. It has the constitution—



Dibenzoyldicinnylenediamine (m. p. 264°).

Heated with a solution of potash in methyl alcohol, it yields benzoic acid and the compound—



Benzenyldicinnylenediamine (m. p. 207°).

The soluble compound melts at 188°. It has the formula—

$$C_{37}H_{30}N_2O_3 = 2C_{14}H_{10}O_2 + C_9H_8O + 2NH_3 - H_2O.$$

As this compound may be regarded as imabenzil in the formation of which 1 mol. of cinnamaldehyde has taken the place of 1 mol. of benzaldehyde, it is proposed to name it *cinnimabenzil*.

This is the fourth of the distinct reactions in which diketones, aldehydes, and ammonia react jointly to form condensation products (comp. *Proc. Chem. Soc.*, 1884, *Trans.*, 672).

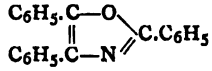
By treatment in the cold with a solution of potash in methyl alcohol, the compound $C_{37}H_{30}N_2O_3$ is decomposed into benzoate and the compound $C_{30}H_{26}N_2O_2$ (m. p. 283°).

48. "*On Imabenzil.*" By the same.

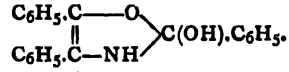
In repeating the work of Laurent on the action of ammonia upon benzil, Henius arrived at the conclusion that the three compounds described by Laurent possessed the following formulæ:—

Imabenzil	..	$C_{42}H_{32}N_2O_4$.
Benzilimide	..	$C_{42}H_{32}N_2O_4$.
Benzilam	..	$C_{42}H_{32}N_2O_2$.

In a preliminary note on the same subject (*Ber.*, xvi., 2636), Dr. Japp showed that benzilam has the formula $C_{21}H_{15}NO$, and that benzilimide, from which it may be obtained by the abstraction of the elements of water, is $C_{21}H_{17}NO_2$. He ascribed to these compounds the constitution—



Benzilam.



Benzilimide.

These formulæ have since been accepted by Henius (*Annalen*, ccxxviii., 339).

In the note above referred to, Dr. Japp further admitted that the formula assigned by Henius to imabenzil was probably correct, basing this opinion upon an examination of *amorphous* imabenzil prepared by the method of Henius.

The authors have now prepared *crystallised* imabenzil, and have been able to rectify its formula, which they find to be $C_{35}H_{28}N_2O_3$. It is formed from benzil and ammonia according to the equation—

$$3C_{14}H_{10}O_2 + 2NH_3 = C_{35}H_{28}N_2O_3 + C_6H_5.COOH + H_2O.$$

Imabenzil as prepared by Henius contains unaltered benzil. Contrary to the statement of Henius, imabenzil can be readily recrystallised; methyl alcohol was found to give the best results. The crystals have been measured by Mr. L. Fletcher, and found to agree with the description and approximate figure given by Laurent. The melting-point was found at 194°.

49. "*On Ammonia-derivatives of Benzoïn.*" By FRANCIS R. JAPP, F.R.S., and W. H. WILSON, Ph.D.

The action of alcoholic ammonia upon benzoïn was studied by Laurent and later by Erdmann. Both these chemists obtained a substance of the formula $C_{28}H_{24}N_2O$, to which Laurent gave the name *benzoïnam*. Erdmann further isolated a substance which he called *benzoïnimide*, assigning to it the formula $C_{14}H_{11}N$.

The authors confirm the formula of Laurent and Erdmann for benzoïnam. Their analyses of benzoïnimide, however, lead to the formula $C_{28}H_{20}N_2$. They regard it as an analogue of diphenanthrylene-azotide, $C_{28}H_{16}N_2$, and as it can no longer be classed as an imide they propose to call it *ditolane-azotide*. It is most readily obtained free from the other compounds formed from benzoïn and ammonia, by heating benzoïn with fused ammonium acetate over a flame until the whole of the ammonium salt is volatilised.

A third compound, not described by the foregoing investigators, was obtained. It is formed in largest quantity when benzoïn is allowed to stand with alcoholic ammonia for several weeks in the cold. It crystallises from alcohol in minute oblique tables or prisms melting at 199°. The analyses agreed best with the formula $C_{28}H_{23}NO_2$. The equation for its formation would be $2C_{14}H_{12}O_2 + NH_3 = C_{28}H_{23}NO_2 + 2H_2O$. As nothing is known concerning its constitution, it may be named, for the sake of distinction, *benzoïnidam*.

50. "*On Compounds from Benzil and Benzoïn and Alcohols.*" By FRANCIS R. JAPP, F.R.S., and JULIUS RASCHEN.

The authors have made experiments to ascertain whether other alcohols besides ethyl alcohol form condensation compounds with benzil in presence of a small quantity of caustic potash in the cold (comp. *Trans.*, 1885, 90). Of the various alcohols employed only isopropyl alcohol yielded a result. A compound of the formula $C_{31}H_{28}O_4$ was obtained, which is deposited from alcohol in small lustrous faintly yellow crystals, of rhombohedral habit, melting at 147° to 148°. The benzil and isopropyl alcohol react according to the equation—

$$2C_{14}H_{10}O_2+C_3H_8O=C_{31}H_{28}O_4+O,$$

and the compound is therefore formed by a process of reduction, and is not analogous to the compound $C_{30}H_{24}O_4$, which, as was shown by Owens and Japp (*loc. cit.*), is formed from ethyl alcohol and benzil merely by elimination of water.

The action of a small quantity of potash at ordinary temperatures upon benzoïn dissolved in various alcohols was also tried, but only in the case of ethyl alcohol was a definite result obtained. Air must be carefully excluded during the reaction, otherwise the benzoïn is oxidised to benzil. Benzoïn slowly reacts with ethyl alcohol in presence of a small quantity of potash,—

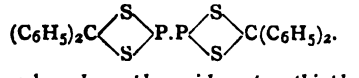
$$3C_{14}H_{12}O_2+2C_2H_6O=C_{46}H_{40}O_4+4H_2O,$$

the compound $C_{46}H_{40}O_4$ thus obtained corresponds with the compound $C_{46}H_{34}O_4$ formed by the interaction of the same molecular proportions of benzil and ethyl alcohol (*loc. cit.*). The benzoin compound $C_{46}H_{40}O_4$ melts at 249 to 250°.

51. "*On the Action of Phosphoric Sulphide on Benzophenone.*" By the same.

By heating benzophenone with phosphoric sulphide for two days at 100° the authors obtained a compound $C_{26}H_{22}S_2$, melting at 152°, previously described by Engler, who prepared it both by the action of alkaline hydrosulphides upon benzophenonidene dichloride, $(C_6H_5)CCl_2$, and by heating benzhydrol with phosphoric sulphide.

At a temperature of 140° to 150° benzophenone and phosphoric sulphide yielded a compound of the formula $C_{26}H_{20}P_2S_5$. It crystallised from hot benzene in colourless microscopic plates melting at 226° to 227°. It decomposes in melting, assuming a deep-blue colour. It may be regarded as an ethereal thio-salt formed by the union of 2 mols. of thiobenzophenone, $(C_6H_5)_2CS$, with 1 mol. of phosphorus sulphide, P_2S_3. Its constitution may be expressed by the formala—



It would thus be a *benzophenonidene pyrothiophosphite.*

On oxidation with a solution of chromic anhydride in glacial acetic acid it yields benzophenone.

52. "*The Separation and Estimation of Zirconium by Means of Hydrogen Peroxide.*" By G. H. BAILEY, D.Sc., Ph.D.

The author has determined zirconium by means of hydrogen peroxide in a number of mixtures containing also iron, titanium, and niobium, and finds that even when the zirconium forms only 2·3 per cent of the mixture, the method of separation which he has previously described (*Trans.*, 1886, 149) is applicable, and the results obtained are accurate. The zirconia precipitated in presence of a large excess of iron or of titanium does not contain a trace of these elements. The oxide generally obtained by means of hydrogen peroxide is the pentoxide, but he has also obtained a higher oxide, ZrO_3, apparently identical with that described by Cléve.

The dried oxides have a composition approximating to $Zr_2O_5.4H_2O$ and $ZrO_3.5H_2O$, though oxygen is lost at 100°, and the product remaining is not definite in composition. Dried at 15°, however, the higher oxide retains the whole of its oxygen, and is evidently more stable than the pentoxide.

Dilute mineral acids and acetic acid, which dissolves freshly precipitated zirconia quite readily, fail to act on these oxides except on prolonged heating.

53. "*An Apparatus for the Determination of the Temperature of Decomposition of Salts.*" By G. H. BAILEY, D.Sc., Ph.D.

The apparatus is for the purpose of maintaining a substance at a given temperature for a prolonged period, and permits of the temperature attained being determined, while any change taking place in the substance can be observed. The author proposes to apply it in the first instance to the study of sulphates used in atomic weight determinations. The bulb of an air-thermometer and a narrow tube into which a boat containing the salt to be heated can be introduced are fixed side by side in a hard glass jacket tube, in shape like a test-tube, which can be heated in an iron tube furnace; the capillary stem of the air thermometer is bent at a right angle and its end is connected by a ground joint to the one limb of a U-tube, charged with mercury, fixed in front of a graduated scale; the other limb of the tube is arranged to act as a gas regulator. The position of the mercury at various temperatures having been once for all determined, it is easy to observe the temperature within the tube to which the substance is subjected; the temperature can be maintained constant to within a degree or two even at high temperatures; and the substance may be withdrawn for examination whenever necessary, or products of decomposition may be sucked out from the tube.

54. "*The Retention of Lead-Salts by Filter-Paper.*" By L. TRANT O'SHEA.

The absorption effect of filter-paper on dilute solutions of metallic salts has not, so far as the author has been able to ascertain, been studied. His attention was drawn to the subject whilst estimating small quantities of lead in water acidulated with sulphuric acid: although the water was perfectly clear, there was a considerable excess of lead in the unfiltered water over that in the water filtered through a single fluted filter-paper.

To test the generality of the phenomenon, various kinds of filter-paper were used. In all the experiments a solution of lead acetate containing 6 m.grms. lead per litre (0·42 grain per gal.) was used, and in each case 50 c.c. (= 0·3 m.grm. Pb) was passed through the filter-paper folded in the ordinary conical form.

Filter-paper.	M.grm. Pb in 50 c c. sol. after filtering through— One filter-paper, 7 c.m. diam.			Two filter-papers, 7 c.c. diam.	
Schleicher u. Schüll	0·18	0·13	0·15	0·06	0·05
English	0·10	0·09	—	0·03	0·05
French, white	0·11	0·11	—	0·05	0·04
„ grey	0·15	0·17	—	0·06	0·03
German, thin (595)..	0·17	0·15	—	0·02	0·02
„ thick (597)	0·15	0·10	0·13	0·00	—
„ thickest ..	0·15	0·13	0·08	0·04	0·06

Though illustrating the phenomenon, these results are not strictly comparable, since the filter-paper was not kept constantly full; consequently larger filter-papers were used which when folded would hold 50 c.c. and the time of filtration noted.

English Filter-paper.

Time in mins.	1·5	1·7	2·25	2·5	2·75	3
M.grms. Pb in 50 c.c. filtered solution ..	0·2	0·23	0·17	0·15	0·11	0·08

French, white.

Time in mins.	3	4	4·2	7	
M.grms. Pb in 50 c.c. filtered sol.	0·22	0·19	0·09	0·05	

French, grey.

Time in mins.	3	3	3·5	7	
M.grms. Pb in 50 c.c. filtered sol.	0·14	0·18	0·1	0·07	

Washing the filter-paper with water after filtration does not effect the removal of the absorbed salt. A Schleicher and Schüll filter-paper, No. 589, *absorbed* during one filtration of 50 c.c. of solution a quantity of salt equivalent to 0·12 m.grm. lead; it then was washed twice with 50 c.c. water—

1st washing *contained* .. 0·02 m.grm. Pb.
2nd „ „ .. 0·00 „

On filtering the same solution twice through the same filter-paper, a quantity of salt equivalent to 0·24 m.grm. Pb was absorbed, and on treating with 50 c.c. water nothing was washed out.

Not only does the absorption take place during filtration but also when the paper is immersed in the lead solution, although at a much slower rate; the amounts of lead remaining after immersing a paper 7 c.m. in diameter in 50 c.c. solution (= 0·3 m.grm. Pb) were as follows:—

Time in hours ..	1.	2.	5.	14.
English	0·03	0·23	0·23	0·05
French, white ..	0·25	0·12	0·05	0·00
„ grey ..	0·27	0·17	0·15	0·04
German, thin (595)	0·25	0·18	0·19	0·03
„ thick (597)	0·25	0·24	0·19	0·00
„ thickest ..	0·25	0·20	0·18	0·00

Research Fund.

A meeting of the Research Fund Committee will be held in June. Fellows desiring grants are requested to make application before June 10th.

At the next meeting, on June 3rd, the following papers will be read:—

"The Effect of Re-melting on the Properties of Iron. Notes on Sir Wm. Fairbairn's 1853 Experiments." By Thomas Turner.

"Some Ammonium Compounds and other Derivatives of (α1') Hydroxyquinoline." By C. A. Kohn, B.Sc., Ph.D.

CORRESPONDENCE.

WATER FOR BOILER PURPOSES.

To the Editor of the Chemical News.

Sir,—I write this letter to see if I can induce some of your English contributors (who have done so much good work in the matter of water analysis) to give any suggestions or results of their investigations upon methods of analysis of, and manner of reporting, *waters for boiler purposes*. The problem is simply this:—To determine reasonably, rapidly, and sufficiently accurately, such constituents of a water, that, by knowing their amounts, we can calculate its scale-forming power. The tests of its hardness, temporary or permanent, or both, by Clark's process or its modifications, or by any other similar method, do not answer the requirements, being not sufficiently accurate; that is one extreme. The other extreme is a complete analysis, such as is made of a mineral water, or as a scientific investigation. Something between the two is wanted; for example, reporting SiO_2, $Al_2O_3+Fe_2O_3$ (to be determined together, save when an abnormal amount of either is present), $CaCO_3$, $MgCO_3$, $CaSO_4$, and alkalies. Such an analysis to be made within three days.

I take up such a standard minor work in this country as Cairns's "Manual of Quantitative Chemical Analysis" is, and read, under "Fresh Water," that "The determination of its value as a potable water can be made by a short and simple analysis, showing the amount of silica, alumina, and oxide of iron, lime, magnesia, soda, potash, chlorine, sulphuric acid, organic and volatile matter (expelled by ignition from the residue left after evaporating a given quantity of water), and ammonia, both free and in a form styled albumenoid, which latter is thought to indicate constituents very detrimental to health. Besides, it is important to know its hardness, or soap-destroying power. This analysis will furnish all the information that is requisite to estimate the fitness of water for use in steam boilers, and for manufacturing purposes." I should say it would; it gives *more* information than is needed or wanted. I object decidedly to such an analysis being called "short and simple," even by omitting the steps pertaining to the character of the organic matter present, which cuts no figure in the discussion I would like to open. For some college professors who have plenty of spare time, or who do not have many waters to examine, such a long analysis may do; but for commercial analysts, or for those who, like myself, are connected with corporations, and who may have, as I have, hundreds—if not thousands—of samples to test, the element of time is an exceedingly important one.

While I am not an old chemist, yet an experience of about fourteen years in chemical work, and much of it spent on waters, has given me a profound distrust of the ordinary water analysis; so much so that I am inclined to believe the average analysis, detailing each constituent to the sixth place of decimals perhaps, to be *entirely incorrect*. We have in this country many an M.D. who can make a water analysis with the utmost ease—and inaccuracy! My chief reason for this disbelief is based upon the fact that all the combinations range from the determinations of the alkalies. Have these incorrectly determined and the ensuing calculations are at fault, resulting in incorrect combinations of the bases and acids. Much care has to be taken in the determination of the alkalies by the usual methods, *i. e.*, by treatment with baric hydrate, ammonic carbonate, hydrochloric acid, ammonic chloride, and subsequent separation of the alkalies by $PtCl_4$. The difficulty lies in *obtaining the alkalies pure*. $MgCl_2$ will sometimes hang on to the very last, and it becomes difficult to prevent its re-dissolving, unless one approaches the opposite danger of insufficient washing. Experiments I have tried upon mixtures of known amounts of pure NaCl, KCl, $CaCO_3$, $CaSO_4$, $MgCO_3$, and $MgCl_2$ showed me that sometimes *twenty* leachings and washings were necessary before all the $MgCl_2$ was extracted and the alkalies left pure. The tediousness and uncertainty of the alkali separation makes the "washing process" given below preferable.

The trouble with any brief method of water analysis is chiefly due to the $CaSO_4$. Thus one can determine SiO_2, $Al_2O_3+Fe_2O_3$, CaO, and MgO as usual. Combining MgO to $MgCO_3$ may do, but it is obvious that the CaO cannot all be figured to $CaCO_3$, for $CaSO_4$ is always present to a greater or lesser degree. If SO_3 is determined, one has not the right to unite it all to the CaO, for some may belong to K and Na. But determining the latter (and Cl) gives us the complete analysis I am trying to avoid.

The process we at present use for the regular analysis, $CaSO_4$ and alkalies, and which partially satisfies us, is as follows:—For each determination we make it an invariable rule to use 1 litre, so that no possible error may be afterward multiplied. We start evaporating at the same time, 1 litre for the total solids and 1 litre for the regular analysis. In the latter we determine SiO_2, $Al_2O_3+Fe_2O_3$ (in ordinary waters it makes a very slight difference whether the latter is reported as given or as $FeCO_3$), CaO, and MgO. The residue from the former, after weighing it as "total solids," is treated with 100 c.c. *boiling water* (in portions), which is supposed to extract *all* the alkalies, *all* the $CaSO_4$, *none* of the $CaCO_3$, and *some* of the $MgCO_3$ (and $MgSO_4$ if present), and filtered. To the filtrate is added NH_4HO and $(NH_4)_2C_2O_4$, whereby both CaO and MgO are precipitated. No HCl is ever added, so that no NH_4Cl can be introduced into the analysis to hold up MgO. The precipitate of the oxalates of CaO and MgO is filtered and washed, and the filtrate evaporated to dry-

ness, and weighed as the "*alkalies by washing*." The precipitate is dissolved in HCl, the solution made alkaline with NH_4HO, again made acid with HCl; finally the CaO is precipitated with NH_4HO and $(NH_4)_2C_2O_4$ as usual, and considered as the $CaSO_4$ of the original water. Wanklyn's method in Chap. II., and p. 95 of Chap. IV. of his 6th ed., consists in weighing his soluble solids, then determining the CaO and MgO in them; the difference he calls alkalies: in our variation we actually weigh them. The CaO existing as $CaSO_4$ is deducted from the total CaO, and the remainder calculated to $CaCO_3$.

Now is the above process a correct one? In waters free from the interference of much organic matter we have found that our "alkalies by washing" come very close to "alkalies by difference," *i.e.*, the difference between the sum of the constituents and the "total solids on evaporation."

So much for the alkalies. As for $CaSO_4$ the question is whether $CaSO_4$ alone, or whether some of the $CaCO_3$ is extracted by the hot water. The statements in the authorities as to the solubilities of CaO and MgO salts vary, so that it is perplexing to know which to accept and which to reject. The following experiments bear on this point:—

A. A mixture of 20 m.grms. pure $CaSO_4$ and 500 m.grms. of a very pure dolomite (composed of 293 m.grms. $CaCO_3$, 201 m.grms. $MgCO_3$, 1 m.grm. SiO_2, and 4½ m.grms. $Al_2O_3+Fe_2O_3$) was evaporated with water to dryness in a platinum dish, and the residue treated with 100 c.c., in portions, of boiling water, and filtered. In the filtrate the lime was determined, while the residue was again treated with 100 c.c. water, filtered, and the lime in its filtrate determined. The residue was a third time treated with 100 c.c. hot water, and the lime determined in the filtrate. Results:—

1.	100 c.c. extracted	10·6	m.grms.	$CaSO_4$.
2.	,, ,,	3·1	,,	,,
3.	,, ,,	3·5	,,	,,
	Total	17·2	,,	,,

(or 2·8 m.grms. short.)

B. Same amounts of same kind of mixture, treated with 400 c.c. boiling water, in portions.
Extracted 20·1 m.grms. $CaSO_4$, or 1-10th m.grm. too much.

C. 40 m.grms. $CaSO_4$ and 500. m.grms. dolomite, with 400 c.c. hot H_2O.
Extracted 31·3 m.grms. $CaSO_4$, or 8·7 m.grms. short.

D. 40 m.grms. $CaSO_4$ (no dolomite), with 500 c.c. hot H_2O.
Extracted 32·5 m.grms. $CaSO_4$, or 7½ m.grms. short.

E. 20 m.grms. $CaSO_4$ (no dolomite), with 500 c.c. hot H_2O.
Extracted 16 m.grms. $CaSO_4$. (The last two trials extracted almost exactly ½ each time.)

I could say more, but feel I have no right to use up more of your space. Still I would like to call attention to the advisability of making reports so that they shall be intelligible to those for whom such work is done. In my case, after giving the chemical data of so many grains per U.S. gal. of SiO_2, $Al_2O_3+Fe_2O_3$, $CaCO_3$, $CaSO_4$, $MgCO_3$ (in some cases $MgSO_4$), alkalies by washing and total solids, we append a second table, which gives the number of grains of "incrusting solids" (all of the above constituents save the alkalies), the number of pounds of these incrusting solids which our standard locomotive tank of 2750 gals. would contain if filled with the water in question, and finally a comparison, giving same data of our standard (Lake Michigan water), and a column in which the Lake Michigan water as unity (1°) is compared with the water in question as (generally) something higher, based upon the varying amounts of incrusting solids.—I am, &c.

WALTER LEE BROWN,
Chemist C. B. & Q. R.R. Co.

Chicago, Burlington, and Quincy Railroad Company, Test Department, U.S.A., Chemical Laboratory, Aurora, Ill., May 11, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 19, May 10, 1886.

Formation of Oxalic Acid in Vegetation.—MM. Berthelot and André.—The authors discuss the formation of oxalic acid in *Amaranthus caudatus*, *Chenopodium quinoa*, and *Mesembrianthemum crystallinum*.

Sounds produced in Vibrating Plates by Discharges of Static Electricity.—E. Semmola.—If a metal plate is traversed by frequent discharges from an electric machine they give a very faint sound, quite distinct from the noise of the spark. To hear these sounds it is necessary to fix the metal plate to the end of a sound collector of ebonite, which is held near to the ear. The sounds become more acute in proportion as the discharges succeed each other more rapidly. The sound is also obtained from a metal plate placed close to a conductor traversed by electric discharges.

Secondary Electrolysis.—E. Semmola.—A small slip of platinum is immersed in the acidulated water of a voltameter, so that its ends may be opposite the electrodes of the voltameter. If an electric current of sufficient intensity is passed into the voltameter there is an escape of hydrogen and oxygen not merely at the electrodes of the voltameter, but also at the extremities of the immersed slip of platinum, which the author calls a third electrode and which acts like a new voltameter. If, instead of platinum, an easily oxidisable metal is employed, this secondary electrolysis becomes much stronger.

The Decomposition-Products of Hypophosphoric Acid: Secondary Hydrate.—A. Joly.—The author refers to a secondary hydrate which he described in *Comptes Rendus*, ci., p. 1058, and cii., p. 110. If the hypophosphoric hydrate is kept a little below 62° the temperature of the melted acid rises gradually several degrees above the temperature of the surrounding medium, indicating that the melted acid is the seat of an exothermic decomposition. The liquid no longer crystallises entirely on cooling, and the portion which remains liquid gives the reaction of phosphorous acid.

Definite Compounds of Hydrochloric Acid and Zinc Chloride.—R. Engel.—The author obtains two distinct compounds of hydrochloric acid and zinc chloride. He finds also that anhydrous zinc chloride may exist in presence of an aqueous solution of zinc chloride.

Combinations of Quinone with the Benzoic Phenols.—MM. de Clermont and Chautard.—The authors have studied the action of the chlorides of acids upon phenoquinone by bringing it in contact with a large excess of acetyl chloride. Monochloro-monacetylic hydroquinone crystallises in silky tufts or in rectangular prisms, perfectly transparent and melting at 62°. Acetyl bromide and benzoyl chloride yield analogous compounds. The author has prepared a third combination of quinone with a diatomic phenol by setting out from pyrocatechine. The new compound forms deep green crystals melting at 153°. Pyrogalloquinone has been previously obtained by Wichelhaus as an instance of the combination of quinone

with a triatomic phenol. Phloroquinone is obtained by bringing in contact 2 mols. phloroglucine and 1 mol. quinone, both in ethereal solutions. It forms fine rectangular tabular crystals, red by transmitted but green by reflected light.

Action of Phosphorus Perchloride upon Hydrocarbons.—A. Colson and H. Gautier.—Phosphorus perchloride renders it possible to prepare symmetric chlorine compounds both in the fatty and the aromatic series, to the exclusion of the isomers which always accompany them if prepared in other manners.

The Rancidity of Butter.—E. Duclaux.—The rancification of butter is not an affair of microbia; it is a spontaneous decomposition of the glycerides of butter. Water promotes it; acidity accelerates it more than alkalinity; salt and borax retard it. All the ethers of butter do not undergo it equally. Butyrine is the least stable, then caproine and the glycerides of the fixed acids. The author suggests the use of water saturated with carbonic acid for washing butter.

Sozolic Acid or Orthoxyphenylsulphurous Acid.—M. Serrant.—The author has previously described this compound under the name of aseptol. Sozolic acid is a true acid surpassing salicylic and phenic acids as an antiseptic.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin
Vol. xix., No. 3.

A Reply.—J. Herzig.—Remarks on Prof. Liebermann's critique on the author's memoirs on quercetine and rhamnetine.

Germanium, Ge, a New Non-Metallic Element. C. Winckler.—The substance of this paper has been already inserted.

Influence of Light on the Progress of Chemical Reactions during the Action of the Halogens upon Aromatic Compounds. — (Fourth Memoir). — Julian Schramm.—Mesitylen is not sensitive to light under the influence of bromine. Mesityl bromide, which is readily formed with the aid of heat, is not formed with the aid of the sun's rays. Monobrom-mesitylen is sensitive to light and on treatment with 1 mol. bromine under these conditions yields para-brom-mesityl-bromide. If pseudocumol is bromised in the sun the hydrogen atoms in the lateral chains are substituted.

Condensation of Bodies of the Urea-Group with Acetacetic Ether.—R. Behrend.—Phenyl-urea combines with acetacetic ether, water being eliminated. The behaviour of sulphurea and of guanidine with acetacetic ether has been studied respectively by R. List and A. Kœhler.

On the Cyanhydrine of Levulose.—(Second Communication).—H. Kiliani.—The author describes the preparation of levulose-cyanhydrine and its behaviour with metallic hydroxides.

On Ethyl-*n*-Propylacetic Acid.—H. Kiliani.—An account of the calcium, strontium, barium, silver, lead, and copper salts of this acid.

On Mixed Methyl-ketones and their Oxidation to α-Ketonic Acids.—A. Claus.—The conclusions to be drawn from the author's results are that the acetyl residue, and in an analogous manner acid residues in general, on their entrance into conjugated hydrocarbons take, if possible, the para-position to a lateral chain, and secondly, the ortho-position to the shortest lateral chain of benzol. Only those methyl-ketones can be directly oxidised to α-ketonic acids in which one lateral chain is in the ortho-position to the ketone-combination.

Reply to A. Jacobsen's Notice on the "History of the Orthoxylidines."—E. Wroblewsky.—A reply to a paper contained in *Berichte* (xviii., No. 17), in which the writer seeks to refute the view that the adjoining xylidine can be prepared by means of the acetyl-derivatives from the mixture of the xylidines as obtained by the reduction of nitrised xylol.

On β-Nitro-naphthaline.—E. Sellman and A. Remy.—The substance which one of the authors formerly described as γ-nitro-naphthylamine, melting at 144°, is found, according to more recent researches, to have the constitution of an orthonitro-α-naphthylamine. It furnishes a suitable material for the preparation of β-nitro-naphthaline.

The Products of the Dry Distillation of some Fatty Salts of Silver.—F. Iwig and O. Hecht.—The authors have examined silver acetate and butyrate. The only demonstrable products obtained from the former are silver, carbon, acetic and carbonic acids, no ethylene or any other combustible gas having been detected. Silver butyric yields essentially the same products, normal butyric acid appearing in place of the acetic.

A Contribution to the Knowledge of the Cyanuric Derivatives.—H. F. Fries.—The author has obtained and examined mono-α-naphthylamised cyanurchloride, the corresponding dicompound, and trinaphthylmelamine.

Propyl Group of Thymol. — O. Widman. — The author demonstrates that normal propyl is present in thymol.

Ortho-Derivatives of Cumenylacrylic Acid, and Chinoline Derivatives thence obtained.—O. Widman.—This very extensive paper does not admit of useful abstraction.

Oxidation Products of Orthonitic Cumenylacrylic Acid, and Compounds therefrom obtained. — O. Widman.—This paper contains accounts of ortho-nitro-cuminic acid, ortho-amido-cuminic acid, ortho-nitro-para-oxypropyl-benzoic acid, ortho-amido-oxypropyl-benzoic acid, ortho-acetamido-oxypropyl-benzoic acid, and ortho-amido-propenyl-benzoic acid.

New Transpositions within the Propyl Group.—O. Widman.—It appears that on simple nitration with fuming nitric acid at 0°, the isopropyl group of cumenyl-acrylic acid is partially transposed into normal propyl. This shows that the acrylic residue, like the methyl group, affects a propyl group in the para position, and predisposes to the formation of normal propyl.

On Nitrosophenol-hypochlorous Ester.—R. Möhlan.—The author undertakes to demonstrate that all the isonitroso- or oximido-compounds, hydroxylamine not excepted, are capable of forming hypochloric esters.

On Symmetric Pyridine-tetracarbonic Acid and ββ′ Pyridine-dicarbonic Acid. — A. Hantzsch and L. Weiss. — The authors have obtained the two acids in question and examined several of their salts.

Isomerism of the Pyridine-dicarbonic Acids.—A. Hantzsch.—A discussion of the identity of these acids. The author considers that Ramsay's α-pyridine-dicarbonic acid represents a chemical individual, and agrees in its essential attributes with αα′ dicarbonic acid.

On Krokonic and Leukonic Acid.—R. Nietzki and T. Benckisser.—This voluminous memoir does not admit of useful abstraction.

On Cyanur-chloride and Cyanuric Acid.—A. Senier. The author examines the behaviour of cyanur-chloride with the salts of various organic acids, and the action of benzoyl chloride upon silver cyanurate.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Part 6.

On the Melam Compounds.—Peter Klason.—Liebig's "pure melam" is a mixture of melam and melem. The former body in contact with acids or alkalies is resolved into ammelin and ammonia, whilst the latter under the same circumstances yields ammelide and ammonia.

Influence of Neutral Salts and of Temperature on the Inversion of Cane-Sugar by Acids.—(Second Treatise).—J. Spohr.—Every acid at each degree of concentration has a certain constant of inversion which is in regular connection with the magnitude of its affinity. The magnitudes of the affinity of one and the same acid at different concentrations are in a determinate regular connection among themselves and with those of other acids. The magnitudes of the affinity of the acids in question are increased under all circumstances by the addition of a neutral salt. The magnitude of the strengthening of affinity by neutral salt added increases with the magnitude of the affinity. The constants of inversion of all acids increase with an increasing temperature almost in the same proportion.

On Normal Melamines.—Peter Klason.—The author describes melamine, trimethyl- and triethyl-melamine, triphenyl- and para-tritolyl-melamine, mono-phenyl-melamine ammeline, thio-ammelin, normal ammelide (Liebig's melanuric acid), ethyl amido-dithio-cyanurate, and diamidothio-cyanurate, and amyl amidothio-cyanurate.

The Oxidation of Oleic and Elaidinic Acids with Potassium Permanganate in an Alkaline Solution.—A. Saytzeff.—This extensive paper does not admit of useful abstraction.

A Process for the Synthesis of Homologues of Anthraquinone.—K. Elbs.—The condensation of ortho-benzoyl-benzoic acid to anthraquinone or anthraquinon-sulphonic acid has long been known, but the attempt has never been made to transform its homologues into the corresponding anthraquinones. This, however, can be effected with tolerable ease and completeness.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxii., Part 2.

Researches on the More Complicated Amidic Acids derived from Meta-amido-benzoic Acid.—These researches consist of a paper by Hugo Schiff, on oxalamido-benzoic acids; a memoir on the benzamic acids of certain monobasic and bibasic acids, by G. Pellizzari; and a paper, by Hugo Schiff, on tartramido- and melamido-benzoic acids.

Examination of Melitose or Raffinose from Treacle, Cotton-seed, and Eucalyptus Manna.—This first dissertation consists of an introduction by B. Tollens; an account of experiments on the raffinose of treacle and cotton-seed, by Dr. P. Rischbiet and B. Tollens; a paper on the melitose from Eucalyptus manna, by B. Tollens; and an attempt, by R. Creydt and B. Tollens, at a quantitative determination of the raffinose in mixtures.

Communications from the Chemical Laboratory of the University of Erlangen.—These consist of papers by Hugo Weil, on diacetonamine; by S. Hegel, on certain derivatives of indol; by E. Fischer and H. Koch, on certain derivatives of trimethylen- and ethylen-diamine; by Max Pickel, on some compounds of phenyl-hydrazine; and by Otto Hess, on the action of brom-acetophenon upon phenyl-hydrazine.

On Naphthyl-hydrazines.—Emil Fischer.—The author describes the preparation of α-naphthyl-hydrazine, and gives an account of its hydrochlorate, sulphate, nitrate, oxalate, and acetate. He has also examined α-naphthylhydrazin-pyruvic acid, aceton-α-naphtyl-hydrazine, its behaviour with nitrous acid, and β-napthyl-hydrazine and some of its salts.

Sulphur Compounds of Tungsten.—Ehrenfried Corleis.—The author has examined the ozysulpho-tungstates, *i. e.*, potassium monosulpho-tungstate, ammonium disulpho-tungstate, potassium trisulpho-tunstate; also the sulpho-tungstates, including normal ammonium sulpho-tungstate and the corresponding potassium and sodium compounds. The following reactions serve to distinguish the normal sulpho-tungstates from the oxy-sulpho-tungstates. If the solution of a sulpho-tungstate is covered with a mixture of alcohol and ether, and hydrochloric acid is added, the ethereal solution becomes dark brown, whilst the watery stratum appears clear and colourless. Oxysulpho-tungstates, if similarly treated, give likewise an ethereal solution more or less deeply coloured, whilst the aqueous stratum is turbid and milky. The two salts may be distinguished by means of solution of zinc sulphate. This does not render the normal sulpho-tungstates turbid. In the solution of a trisulpho-tungstate there soon appears a lemon-yellow turbidity, which becomes a copious yellow precipitate, soluble in hydrochloric acid, with a reddish brown colour. In this solution there soon appears a dark grey-blue precipitate. The solution of a disulpho-tungstate gives an immediate light yellow precipitate with zinc sulphate. Hydrochloric acid renders the liquid clear again, but a dirty blue precipitate is soon formed. Monosulpho-tungstates give the zinc sulphate a white precipitate, soluble in hydrochloric acid. This solution, on standing, deposits a white precipitate, which soon takes a bluish shade. The formation of the sulpho-tungstic acids seems in part dependent upon the base, as on the action of hydrogen sulphide upon potassium tungstate there are formed mono- and trisulpho-tungstates, whilst if the ammonium salt is taken the disulpho-tungstate and the normal sulpho-tungstate are formed. Tungsten therefore in this respect behaves similarly to molybdenum.

On Hypophosphoric Acid.—T. Salzer.—The author contests Sanger's view that this acid, on concentration, is resolved not into phosphorous and pyrophosphoric acids, but into phosphorous and orthophosphoric acids.

MEETINGS FOR THE WEEK.

Tuesday, June 1st.—Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
Thursday, 3rd.—Royal Institution, 3. "Habit as a Factor in Human Morphology," by Prof. A. Macalister, F.R.S.
—— Chemical, 8.
Friday, 4th.—Royal Institution, 9. "The Sympathetic Nervous System," by W. H. Gaskell, F.R.S.
—— Geologists' Association, 8.
Saturday, 5th.—Royal Institution, 3. "Light, with special reference to Effects resulting from its Action on various substances," by Prof. Stokes, Pres.R.S.
—— Physical, 3. "On Electric Light Fire-Damp Indicators," by Messrs. W. Emmott and W. Ackroyd.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Leaden Earrings.—Will any contributor—foreign or otherwise—kindly inform me whether the custom of ear-piercing with leaden rings is peculiar to Russia, and, if not, where else that idea has obtained favour? Also, has lead any pernicious ingredient for permanent wear as earrings?—B. Jones.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1384.

HOLMIA, THE EARTH X OF M. SORET, CONTAINS AT LEAST TWO METALLIC RADICLES.

By M. LECOQ DE BOISBAUDRAN.

The author demanded the opening of a sealed paper which he had deposited on April 27, 1886. This paper, marked No. 4044, was opened during the session by the Perpetual Secretary and contained the following memoir :—

In October, 1878 (*Comptes Rendus*, lxxxvii., p. 559), M. Delafontaine announced a new earth, philippia, and ascribed to it the strong absorption-band situate at about 164·25 of the author's scale (λ=451·5), which band was included in the spectrum of the former erbia.

In the beginning of 1880 (*Comptes Rendus*, xc., p. 221) M. Delafontaine recognised that the band 451·5 is due to the same body as the other bands considered by M. Soret and M. Clève as characteristic of holmium. M. Delafontaine added that this holmium was identical with his philippium, and in particular that no fact hindered him from admitting that the band 451·5 was derived from the same body as the bands 640·4 and 536·3.

Lastly in August, 1880 (*Comptes Rendus*, xci., p. 378), and September, 1880 (*Archives des Sciences Physiques et Naturelles*, p. 80; Geneva, Sept. 15, 1880), M. Soret recalled the fact that M. Delafontaine had renounced his old idea of the identity of holmium and philippium on finding that the latter body gave no visible absorption-spectrum, and that the bands which he had ascribed to it at first really belong to holmium.

It results from this short historical summary of the question :—

1. That M. Delafontaine's philippium has no absorption-spectrum.
2. That all the bands of the following table, drawn up by M. Soret, are at present regarded as belonging to a single element, holmium.

Visible Spectrum of the Earth X or Holmia.

804 (?)	Very strong.
753	Weak.
640·4 } 536·3 }	Very characteristic.
485·5	
474·5	Very weak and misty.
453 to 449	
430	Doubtful.
414·5	
389 to 387.	

The author has, however, succeeded by means of several hundred fractionations with ammonia and potassium sulphate, in obtaining earths showing very plainly 753 and 451·5, in the complete absence of 640·4 and 536·3, and on the other hand earths showing 753 and 451·5 much more faintly, though 640·4 and 536·3 were seen very distinctly. The oxide hitherto called holmia is therefore not homogeneous, and contains *at least* two radicles.

As the bands 640·4 and 536·3 are those especially which served M. Soret and M. Clève for recognising the presence of a new element in the old erbium, the author proposes to retain the name holmium for the element which produces these bands, and to call the metal giving the bands 753 and 451·5 *dysprosium** (Dy).

* From δυσπρόσιτος, difficult to approach.

The question has now to be decided whether 640·4 and 536·3 are really due to the same earth, and a similar question arises for 753 and 451·5.

M. Soret indicates 753 as faint. The author sees it very strong in specimens which give neither 640·4 nor 536·3, whilst it is almost null in cases where 640·4 and 536·3 are quite distinct, and where 451·5 is still seen plainly, though much attenuated. According to the present state of the author's observations the bands 753 and 451·5 seem to follow the same variations in intensity.

As for the other bands contained in the above table they have to be classified to see if they can all be distributed between the spectra HO and Dy. In fractionations with potassium sulphate and alcohol the first precipitates contain especially the terbia, then come dysprosia, holmia, and lastly erbia.—*Comptes Rendus*, cii., p. 1003.

ON DYSPROSIUM.

By M. LECOQ DE BOISBAUDRAN.

Since the deposit of the sealed paper above referred to the author has continued his observations, which he here summarises.

The earths which no longer show the absorption-rays of holmium (640·4 and 536·3), but which give very distinctly the bands of dysprosium (753 and 451·5), are still very rich in terbia. Still these bands (753 and 451·5) cannot be ascribed to terbia itself any more than the others spoken of, since they are notably stronger in earths which are relatively pale than in the most highly-coloured terbia. But a deep reddish yellow tint is the distinguishing character of terbia.

The bands of Dy are not due to erbium, samarium, or didymium, the chief rays of which are invisible in the author's best preparations. The fractionations with potassium sulphate and alcohol always eliminated didymium and samarium at the beginning of the series, and erbium at the end, even beyond holmium.

With earths thus purified there are seen, besides 753 and 451·5,—

1. A certain indication of 804. This band is at the extreme limit of the spectrum visible in the author's instrument. Its presence only has been distinguished, and that not without difficulty.
2. A large nebulous band, having its centre placed at about 148·3 of the author's scale (λ=475). This band must not be confounded with that, narrower and a little more refrangible, which is easily seen when holmium is abundant, and for which its author gives the following position: Ho, 149·1, λ=473·7, apparent middle. Width about 2½ divisions. More nebulous on the left than on the right.
3. A ray or narrow band, probably that indicated by M. Soret as doubtful at λ=430. The author gives its position as 183·7, λ+427·5. This band is easily visible in all his preparations of pure dysprosium,* and in mixtures containing both dysprosium and holmium.

To sum up, the following bands undergo the same variations of intensity, and seem due to dysprosium. The author makes reservations, however, as regards 804, which he has not yet studied sufficiently. With this exception he gives the following determinations which he has made, considering them, however, as merely provisional and approximate :—(See Table next column).

The author has long been satisfied of the impossibility of ascribing the band β 148·3 (λ=475) to any known body, including holmium, as defined by its absorption-spectrum given in M. Soret's table. But the uncommon difficulty of separating dysprosium from holmium and erbium, on

* Pure as regards the absorption spectrum, but containing much terbia.

Micrometer.	λ	
	804·0	Broader than 756·3, but much less apparent. (Perhaps from the want of light in this portion of the spectrum ?)
γ. 67·06 about.	756·5	Rather narrow. M. Soret gives its position λ=753, but it ought to be the same band.
β. 148·3 about.	475·0	Very nebulous, and from 4¼ to 5 divisions of the micrometer in breadth.
α. 164·2	451·5	Nebulous outlines, but less vague than those of the former. Breadth from 4 to 4½ degrees of the micrometer. Much stronger than 475.
δ. 183·7 about.	427·5	Rather narrow, but seeming a little broader than 756·5.

the one hand, and from terbium on the other, has induced him to keep back this observation.

The lack of material arising from the numerous fractionations has been a great hindrance in this investigation. —*Comptes Rendus*, cii., p. 1005.

RELATION OF "TRANSFER-RESISTANCE" TO THE MOLECULAR WEIGHT AND CHEMICAL COMPOSITION OF ELECTROLYTES.*

By G. GORE, LL.D., F.R.S.

In the full paper the author first describes the method he employed for measuring the "resistance," and then gives the numerical results of the measurements in the form of a series of tables.

He took a number of groups of chemically related acids and salts of considerable degrees of purity, all of them in the proportion of their chemical equivalent weights, and dissolved in equal and sufficient quantities of distilled water to form quite dilute solutions. The number of solutions was about seventy, and included those of hydriodic, hydrobromic, hydrochloric, hydrofluoric, nitric, and sulphuric acids; the iodides, bromides, chlorides, fluorides, hydrates, carbonates, nitrates, and sulphates of ammonium, cæsium, rubidium, potassium, sodium, and lithium; the chlorides, hydrates, and nitrates of barium, strontium, and calcium; and a series of stronger solutions, of equivalent strengths to each other, of the chlorides of hydrogen, ammonium, rubidium, potassium, sodium, lithium, barium, strontium, and calcium. A series of similar liquids to those of one of the groups of acids, of equal (not of equivalent) strength to each other, was also included.

As electrodes he employed pairs of plates of zinc, cadmium, lead, tin, iron, nickel, copper, silver, gold, palladium, and platinum; and separate ones formed of bars of iridium.

He took each group of solutions, and measured in each liquid separately, at atmospheric temperature, the "total resistance" at the two electrodes, and the separate "resistances" at the anode and cathode respectively with each metal, and thus obtained about seventy different tables, each containing about thirty-six measurements, including the amounts of "total," "anode," and "cathode resistance" of each metal, and the "averages" of these for all the metals.

By comparing the numbers thus obtained, and by general logical analysis of the whole of the results, he has arrived at various conclusions, of which the following are the most important:—The phenomenon of "transfer-resistance" appears to be *a new physical relation of the atomic weights*, attended by inseparable electrolytic and other concomitants (one of which is liberation of heat,—*Phil. Mag.*, 1886, vol. xxi., p. 130). In the chemical groups of substances examined *it varied inversely as the atomic weights of the constituents, both electro-positive and electro-negative, of the electrolyte, independent of all other circumstances*; and in consequence of being largely diminished by corrosion of the electrodes, it appeared to be intimately related to "surface-tension." He suggests that such corrosion may be a consequence, and not the cause of small "transfer-resistance." The strongest evidence of the existence of the above general law was obtained with liquids and electrolytes with which there was the least corrosion and the least formation of undissolved films: those liquids were dilute alkaline chlorides, with electrodes of platinum.

This research is an extension of a former one on "Transfer-resistance in Electrolytic and Voltaic Cells," communicated to the Royal Society, March 2nd, 1885. Further evidence on the same subject has been published by the author, in the *Philosophical Magazine*, 1886, vol. xxi., pp. 130, 145, 249.

* Abstract of a Paper read before the Royal Society, May 20th, 1886.

ON AN ERROR IN THE NITROMETRIC ASSAY OF VITRIOL.

By THOMAS BAYLEY.

A short time ago I made a communication on this subject to the Chemical News, which was in effect a reply to Prof. Lunge, who had called in question some experiments I had made on the estimation of nitrogen compounds in vitriol. Prof. Lunge has since returned to the subject. The controversy can be epitomised in a few words. When, after shaking the nitrometer in the usual way for the estimation of "nitre," the evolved gas is measured and allowed to escape, and a quantity of water about equal in volume to the sulphuric acid solution of mercurous sulphate is added, without contact of the latter with air, further shaking frequently causes the liberation of an additional small but varying volume of nitric oxide gas. This *fact*, observed by me, was quoted by Mr. A. H. Allen in a paper on the nitrometer, in support of an opinion, which has been shared by other writers, that nitric oxide is soluble in sulphuric acid. Of course the observation does not afford proof of that hypothesis, although it appears to support it. Prof. Lunge, however, after shaking pure nitric oxide with pure sulphuric acid, and thereby demonstrating the insolubility of the gas in the acid, and nothing more, applied this result to prove that no nitric oxide could be dissolved by the mercurous solution in the nitrometer, although Miller, Watts, Gmelin, and other chemists have ascribed a solvent power over this gas to mercurous and other salts. I admit that I was myself in error when, misled by interpretation of statements by various authors, apparently confirmed by the appearance of the gas in question on dilution of the vitriol, I held the retention of the nitric oxide to be due to the mercurous sulphate. Indeed, further experiments by Lunge and Pattinson show that the mercurous salt has not this power of solution under the conditions of the experiment, and Prof. Lunge now "affirms that these quantities" (of nitric oxide) "dissolved must be, in any case, so minute as to be inappreciable in practical work, and denies that the addition of water causes the operation to be more correct by the liberation of a sensible quantity of nitric oxide previously dissolved in the acid liquid."

My observations must now more than ever be inaccurate; but Prof. Lunge will not now "hazard a guess by what fault of manipulation the inaccuracy arose," but he draws attention to one point which has frequently caused him to reject his own tests: this is the clinging of a drop of acid to the narrow part of the tube under the tap. After the "ordinary" shaking this of course gets washed

down by added water, and would cause a liberation of gas, "0·5, as Mr. Bayley has frequently found, or more or less, according to the original fault in manipulation." I have used the original (Davis's) two-way nitrometer and the three-way instrument (introduced by Lunge), and, with both, the mercury has immediately on shaking formed a froth in this narrow space, and so displaced this film or drop. But after shaking and expelling the gas, both mercury and sulphuric acid have been added through the tap, thoroughly cleansed, in order to wash down this film, and no additional volume of gas has ever appeared, although water has afterwards caused its liberation. These precautions were taken from the beginning, and others in addition, such as the thorough boiling of the water immediately before use in the experiment. This point some further prophet of the nitrometer would do well to call attention to.

Nitric oxide is, however, certainly retained by the liquid in the instrument, not only when using common vitriol (for which the method is most employed), but in the case of much of the "pur" acid of the shops. The latter is purified by dilution, decantation from sulphate of lead, and rectification with ammonium sulphate. It is evident that this will not remove such impurities as copper, iron, and other metals. Iron especially is frequently present; the Pocket-book of the German Alkali-makers contains a method for its estimation involving the use of $\frac{1}{10}$ N permanganate.

The presence of iron is the cause of the solubility of gas in the nitrometer; the following experiments have made this clear.

Iron Solution.

A solution was made by dissolving 0·5 grm. of $FeSO_4$,5aq. in a small quantity of water, and diluting to 50 c.c. with concentrated pure sulphuric acid. This amount of salt is not permanently soluble, but the experiments were made before any crystallised out.

Nitre Solution.

A solution was made containing 0·5 grm. KNO_3 in 50 c.c. of pure conc. sulphuric acid.

One c.c. of nitre solution was shaken in the instrument and 2·2 c.c. of gas were liberated (at 19° C.), pure sulphuric acid being used to wash in the sample.

In another experiment 1 c.c. of nitre solution, washed in with 5 c.c. of the iron solution, in two batches, gave only 0·2 c.c. of gas, even on long standing, 2 c.c. being dissolved; and of this dissolved portion only 0·7 c.c. was liberated by 5 c.c. of water, the solution changing from dark port-wine red to a brownish orange.

Using a sample of Glover acid containing 0·05 per cent of Fe the same dark colour was observed, and 0·4 c.c. was liberated on dilution.

A quantity (1·5 c.c.) of nitre solution having been used, which liberated 3·3 c.c. of gas, 5 c.c. of iron solution, holding some salt in suspension, were added; on shaking for ten minutes nearly all the gas dissolved, and ultimately all but 0·2 c.c. passed into solution.

These experiments may be repeated indefinitely with similar results, and indicate that the presence of iron in common vitriol, and in "*pur.*" sulphuric acid, may cause a not inconsiderable error in vitriol testing. Thus, supposing 5 c.c. of such an acid, as the nitre solution represents, were under trial, each c.c. would dissolve 0·4 c.c. of gas, corresponding to 0·144 grm. of $NaNO_3$ per 100 c.c.; which error would be increased by the use of a similarly vitiated "*pur.*" acid in rinsing in. And if such 5 c.c. of acid, free from nitre, were used in any other nitrometric test, the total volume suppressed (viz., 2·0 c.c.) would not be trivial.

Again, the quantity actually dissolved is an unknown amount, because all is not liberated on dilution with a practicable volume of water.

The colour of the solution affords an estimation of the amount of iron present; 0·002 grm. of the metal imparts a deep port-wine red to 6 c.c. of acid: probably 1-100th of the amount of colour would be appreciated without difficulty. The method might be applied as a colour-test for iron, and for the study of the compounds of iron sulphate and nitric oxide. Salts of copper, cobalt, nickel, chromium, and uranium absorb no gas under the conditions of the experiment. Copper produces a trancient puce colour, and seems to cause absorption at first, but on continued shaking the whole of the nitric oxide is liberated.

THE UNITED STATES LABORATORY AT THE NEW YORK PUBLIC STORES.

By MARCUS BENJAMIN, Ph.B., F.C.S.

SEVEN years ago, at the September term of the District Court of the United States for the district of Maryland, there was tried the famous Demerara Sugar Case. At that time the duties payable on sugar were levied according to the colour, the Dutch Standard being the criterion by which the shade was determined. This standard was simply a series of bottles containing sugars of a known degree of purity, with which the imported sample was compared, and then accordingly classified. For a year or more previous to the trial just mentioned, sugars that were supposed to be artificially coloured or darkened had been imported into this country: but as it was almost impossible to satisfactorily prove such an assumption, no direct efforts to interfere with their introduction were undertaken. The use of the polariscope was agitated, and the matter carefully considered by the Treasury Department at Washington. Meetings of prominent merchants and importers were held in New York and other cities, and the subject was thoroughly canvassed. Finally, a large quantity of artificially darkened sugar was seized, and the trial at Baltimore followed. The jury decided, *first*, "that the sugars were artificially coloured after crystallisation," and, *second*, that "the importer introduced them with an intent to defraud the United States." One striking fact was emphasized throughout all the testimony introduced, irrespective of the side by whom the opinion was advanced. It was that "there is no determinate relation between the colour of sugars and their polarisation or saccharine value." This consideration soon led to the issuing of an order by the Secretary of the Treasury, John Sherman, requiring the adoption of the polariscope for the examination of sugars in the Customs Service, with the gradual abandonment of the Dutch Standard as an authority. The sugar-importing ports were before long equipped with polariscopes, and such articles as were necessary for the analysis of sugar and molasses. Portland, Boston, New York, Philadelphia, Baltimore, New Orleans, and San Francisco received outfits of chemical apparatus, and experts were detailed to prosecute the examinations. The port of New York, which exceeds all the others combined in the value and variety of its imports, was selected as the best locality at which to establish a general chemical laboratory for the Customs service, and it was deemed best that the chemical laboratory should be under the same general management as the sugar laboratory. In the latter part of the year 1878, Dr. William C. Tilden, who had recently acted as Professor of Chemistry at the Howard University, of Washington, D.C., was appointed in charge, and Mr. Edward Mayers, an expert who had given valuable testimony on the side of the Government at the Baltimore trial, was selected to direct the sugar-work. Rooms at 128, Hudson Street, were hired, and the work was begun. Various determinations of morphine, of iron ores, alcohols, &c., were carried on. After a year's experience at the place mentioned, the amount of work having considerably increased, larger accommodations were necessary, and the U.S. Laboratory was moved to the corner of Grand and Varick Streets. In the meanwhile the force had been augmented by the appointment

of Dr. Jesse Park Battershall, a well-known analytical chemist of New York city, and a graduate, with high honours, of the famous German University of Tubingen. This gentleman's experience and thorough chemical knowledge made his services the most valuable acquisition that the U.S. Laboratory has ever received. It is his just due to say that the professional recognition of the work performed under his supervision is about the only consideration that has kept the chemical reports free from suspicion. Dr. Battershall entered the service in July, 1879. Dr. H. M. Baker, a gentleman whose familiarity with dyes and various colouring materials made his services desirable for the examination of the coal-tar products then arriving at this port, had also been appointed for work in this new bureau. Dr. Tilden was subsequently removed, and, in May, 1880, Mr. Edward Sherer, a sugar chemist, was appointed to the control of the laboratory. Two years passed away, and again a removal took place. New quarters were found at 393, Canal Street, over the People's Bank. During the year 1881, 3533 samples of sugars and of syrups or cane-juice were tested by the polariscope, but in March of the following year a decision of the Supreme Court resulted in an order from the Treasury Department discontinuing the use of the polariscope and other chemical tests, and directing that such examinations be made simply by the Dutch Standard of colour. The number of sugar determinations in 1882 were therefore comparatively few, being only some 771 in number, while for the year 1884 the number of polarisations increased to upwards of 30,000.

The amount of work executed in the other divisions of the laboratory during 1882 was of great importance. It was estimated that 115,052·64 dollars of additional duties were collected by the Government in consideration of the information derived from the chemical analyses furnished by Dr. Battershall, on three items alone, viz., oxides of iron, bone-black, and iron ores. Valuable service was rendered by chemically determining the identity of the various dyes that were imported. Such determinations made possible the proper appraisement of the invoices, and thereby enabled the authorities to collect the just amount of duty. On June 1st, 1883, the revised tariff law came into force. An increased amount of chemical work was one of the immediate results of its enactment. New employés, additional facilities, and greater space were at once necessary. The first of these requirements was provided for by adding to the force six examiners, some of whom were only accepted after a Civil Service examination. Among the latter were J. Howard Wainwright, F.C.S., and the writer, both graduates of Columbia College School of Mines.

By the securing and fitting up specially for the U.S. Laboratory the building located at the north-east corner of Hubert and West Streets, the remaining difficulties were apparently overcome. The four floors of this building are in direct communication, forming, in fact, a part of the U.S. Appraiser's stores. Possession of the new offices was taken during the latter part of the summer of 1883, and it seemed as if at last the laboratory had secured a permanent home; but already the space seems too small, and complaint is made that the work is hampered by the lack of room.

Before describing the work performed in each of the three branches of the office, a few observations on the general functions of the laboratory will aid in explaining its field of operations.

It is the only general chemical laboratory connected with the U.S. Customs Service, and therefore various articles are sent to New York for chemical analysis from every other port of entry in the country. Important questions of a scientific nature are frequently received from Washington, demanding a careful investigation at the hands of the experts here in office. Among other duties are the preparation of reports for special agents. This work has frequently been of the greatest value in exposing frauds in importations. The amount of drawback is, whenever possible, determined by chemical analysis.

Besides the foregoing, reports of analyses are furnished to the following divisions of the Appraiser's stores, on the subjects as herewith given:—

4th Division.—Silks and fabrics.
6th ,, —Wool and hair.
7th ,, —Dyes, drugs, and chemicals.
8th ,, —Sugar.
9th ,, —Metals, ores, &c.
11th ,, —Groceries, teas, liquors, &c.

And, also, reports are furnished to the 7th Division of the U.S. Custom-House.

The upper floor of the building is the special domain of Dr. H. M. Baker. In this room the aniline dyes and colours are identified, the different fabrics examined and classified; microscopic examinations of wools and hair are made, besides microscopic examination for the second division, and special investigations required by the Appraiser.

The identification of various hairs forms an exceedingly interesting part of Dr. Baker's work. The specimens are received from the sixth division, and from a microscopical examination it is determined whether the material is goat's hair or camel's. At times samples of human hair have been tested. In the Annual Report for the year 1884, twelve quantitative goat-hair determinations are recorded; four yak-hair estimations are likewise mentioned. The colour estimations are comparative examinations between dyed samples of wool prepared from standards in the possession of the laboratory, and similar samples prepared from the specimen of dye under consideration. A visitor to Dr. Baker's laboratory will often see drying skeins of wool suspended from the ceiling, resplendent with all the brilliant colours of the magnificent coal-tar products, rivalling, in beauty and delicacy of shade, an Eastern flower-garden. The wonders of chemistry are before us, and, as we glance from the lump of crude tar, or from the indifferent aniline oil to the exquisite loveliness of the eosine and many other dyes, we cannot but wonder if the chemist is not in some way connected with the magician of olden times.

The floor beneath is devoted to the analysis of sugar. The work here performed is beyond doubt the most important, from a pecuniary standpoint, of all that is executed in the laboratory. The Report for the month of March, 1885, reads as follows:—

	Tons.
No. of samples tested in duplicate	1567
Samples requiring a third test	65
Total number of tests..	3199
Damaged samples tested 58	
Re-tests performed 84	
Comparative tests 22	
—	164
Making a grand total of	3363

The Annual Report for 1884 stated that 132,022 polarisations of sugars and molasses were made. The estimated cost of this work, if performed by expert chemists outside of the Government employ, was 16,011 dollars, while the actual expense to the United States for this work, including salaries, gas, rent, and apparatus, was only 12,142·13 dols. A saving of 3 868·87 dols. was thereby effected. A better appreciation of this work may perhaps be had from the statement that during the past year there was imported into New York 755,353 tons (2240 lbs. each), having an approximate value of 86,000,000 dols., on which duty to the amount of not less than 25,000,000 dols. was paid.

About ten men are continuously engaged in the work of examining sugar. The crude article is received from the sampling room in tin boxes holding about 1 lb. each. The

sample, or the contents of each box, is thoroughly mixed by being ground in a porcelain mortar, and then handed to the weighers, of whom there are four. After weighing, and 13·024 grms. is standard weight taken, the samples are brought into solution with water in a 50 c.c. flask. When the sugar is completely dissolved a few drops of lead acetate are added. Then the solution is increased exactly to 50 c.c. by adding water, well shaken and filtered, and the filtrate poured into the polariscope tube. There are five polariscopes in constant use in the sugar room. They are of the Scheibler variety, and are made in Berlin, Germany. The law requires the examination of sugar to be made in duplicate, and therefore an agreement to within three-tenths of a per cent is necessary before a report of the saccharine strength of a sample can be made. This sometimes necessitates a re-examination of the sample, and frequently, when the sugar is a poor one, four or five re-tests are made before concordant results are obtained. Examinations of damaged samples of sugar form part of the work required of the experts in this room. Damaged sugars are those which have become injured during the sea voyage to this country, and therefore, in addition to the polarisation, a determination of the amount of moisture contained in the sugar is necessary. This estimation is made by weighing a quantity of the sugar in a porcelain dish, drying at 100° C. to constant weight, and again weighing. The difference between the two weights is the amount of moisture. Every month a series of so-called comparative tests are exchanged between the sugar-importing ports. These tests are simply determinations of moisture and of the saccharine strength by the polariscope, which are verified or "compared" by the receiving port. By this means any important variations in value of the instruments would at once be detected. Mr. Wm. D. Crumbie, one of the examiners connected with the laboratory at New York, tests all the sugar received at New Haven. He is telegraphed for at once on the arrival of a cargo of sugar. The examination of sugars is dispensed with for the present at Portland, Me. During 1884 only 13,380 tons of sugar were received at Portland, New Haven, and other Eastern ports.

Descending another flight of stairs we reach the office and library. The latter is a comparatively well-selected lot of working books. It contains sets of Watts's "Dictionary of Chemistry," Leopold Gmelin's "Handbook of Chemistry" as published by the Cavendish Society, Spon's "Encyclopædia of the Industrial Arts," Ure's "Dictionary of Arts, Manufactures, and Mines," Lippincott's "Encyclopædia of Chemistry," Roscoe and Schorlemmer's "Treatise on Chemistry," &c. A complete set of the CHEMICAL NEWS, of London, from its beginning up to the present date, is one of the few "treasures" in the book case. In all there are, perhaps, some hundred and fifty volumes, but as the laboratory grows the number of books will increase, so that the nucleus at present formed may become, in time, a valuable part of the laboratory.

Continued Vol 53 p 29

NOTE ON THE REDUCTION OF FERRIC SOLUTIONS BY THE USE OF AMALGAMATED ZINC AND PLATINUM FOIL.*

By ALFRED L. BEEBE, School of Mines, New York City.

IN the determination of iron in sulphuric acid solution by titration with potassium permanganate, amalgamated zinc and platinum foil are very generally employed to reduce the iron to the ferrous state. As ordinarily employed, their use for this purpose is frequently attended with two practical difficulties. The first is the amalgamation of the platinum strip through its contact with the zinc, and the consequent cessation of all reducing action. The second is encountered in transferring the solution from the reducing-bottle to the beaker in which the titration is to be made. Unless great care is exercised in this operation the zinc will fall into the beaker, fracturing it, and causing the loss of the analysis.

The following simple modification of the usual method has been found by the writer to obviate entirely the difficulties above referred to. A strip of thin platinum foil about one inch square is perforated with pin-holes over its entire surface. It is then bent into the shape of a letter U, and its opposite corners are connected by short pieces of platinum wire, so as to form a sort of basket. In this is placed a piece of amalgamated zinc of convenient size, and the whole is suspended by a stout platinum or silver wire in the bottle containing the solution to be reduced. Another strip of platinum foil, about 1½" × 2½" in size, is then dropped into the bottle in such a way as to lean against the wire supporting the basket and zinc without coming into contact with the latter.

Galvanic action at once commences and hydrogen is evolved in abundance from the surface of the foil, which never becomes amalgamated, as it comes into indirect contact only with the zinc.

When the reduction is complete the platinum basket containing the zinc is removed from the solution, washed in the titrating beaker, and laid aside, all danger of fracturing the beaker being thus avoided.

* *Transactions of the American Institute of Mining Engineers*, Pittsburgh Meeting.

A LECTURE EXPERIMENT FOR SHOWING THE COMPOSITION BY VOLUME OF NITROUS AND NITRIC OXIDES.*

By E. H. KEISER.

THE usual method of showing that nitrous oxide contains its own volume of nitrogen, and that nitric oxide contains half its volume of nitrogen, is to decompose these gases by bringing them in contact with heated potassium. For this purpose a quantity of the gas to be examined is collected in a eudiometer over mercury, and its volume is determined. The gas is then transferred to a bent glass tube closed at one end, and a small piece of potassium is introduced into the bent portion of the tube by passing it up through the mercury by means of a wire. The lower and open end of the tube is now closed under the mercury with the finger, and the part of the tube containing the potassium is heated with the lamp. After the combustion the tube is allowed to cool. The gas, which now consists of nitrogen, is transferred back again to the eudiometer, and its volume is determined. To perform this experiment successfully, considerable skill in the manipulation of gases is necessary, and it requires so much time that it is not adapted to the purposes of the lecture table.

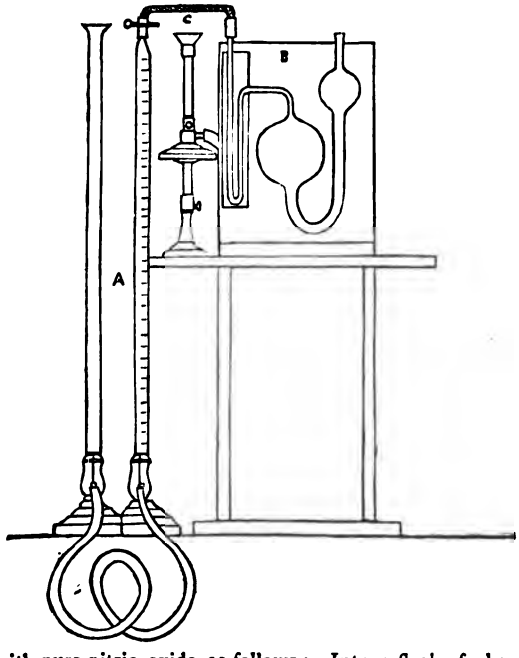
The same object may be attained much more easily and rapidly by means of the simple apparatus shown in the cut. It is based upon the fact that heated metallic copper combines with all the oxygen of the nitrogen oxides and sets the nitrogen free. The method of using the apparatus is very simple, and requires but little explanation. A represents a gas burette for measuring the volumes of the gases. B is a gas pipette, which is filled with water. The connecting-tube, C, is made of hard glass, and is 3 m.m. internal diameter, and from 10 to 12 c.m. long. It is completely filled with granular metallic copper, which has been obtained by the reduction of the granular oxide in a current of hydrogen. The copper is held in place by plugs of asbestos in each end of the tube. To decompose the oxides of nitrogen, this tube is heated to a red-heat with a Bunsen burner, and, to prevent it from bending,

* *American Chemical Journal*, vol. viii., No. 2.

a piece of wire gauze is wrapped around the outside and secured by wires.

A measured quantity of nitrous or nitric oxide contained in the burette A is passed over the heated copper by opening the pinch-cock and raising the reservoir tube of the burette. When the reservoir tube is lowered, the gas is drawn back from the pipette. It now consists of nitrogen, and its volume may be readily determined. If nitric oxide has been used, the volume of nitrogen obtained will be exactly one-half the original volume of the gas, while in the case of nitrous oxide the volume of nitrogen will be the same as the volume of nitrous oxide taken, although the copper will have been oxidised and the gas will have lost its power of supporting combustion. The error rarely exceeds 0·1 per cent in the case of nitric oxide, while with nitrous oxide equally good results are obtained if the water in the burette has been previously saturated with the gas.

It is of course necessary to have the oxides of nitrogen free from air. The burette may be conveniently filled



with pure nitric oxide as follows:—Into a flask of about 300 c.c. capacity there is placed a mixture of 100 grms. of ferrous sulphate and 12 grms. of potassium nitrate. To this is added a quantity of dilute sulphuric acid, obtained by mixing 60 c.c. of the concentrated acid with 160 c.c. of water. The flask is closed with a one-hole rubber stopper, through which passes a glass tube bent at right angles. On heating the mixture contained in the flask pure nitric acid is evolved. A T tube is then attached to the gas burette, and one of its branches is connected with the outlet tube of the flask. The air in the burette is expelled by opening the pinch-cock and raising the reservoir tube until water flows out of the open end of the T tube. After all the air has been expelled from the generating flask the open end of the T tube is closed with a rubber tube and pinch-cock, and the gas allowed to pass into the burette.

The same apparatus serves for filling the burette with nitrous oxide, the gas in this case being made by heating pure ammonium nitrate.

Condensation of Pyridin.—C. F. Roth.—The author has obtained a dipyridil which requires further examination.—*Ber. der Deutsch. Chem. Gesell.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

May 22nd, 1886.

Prof. Balfour Stewart, President, in the Chair.

The following were elected Members of the Society:—Messrs. C. A. Bell, E. C. Johnson, and James Swinburne.

The following communications were read:—

"*On the Sympathetic Vibrations of Jets.*" By Mr. Chichester A. Bell.

It has been assumed hitherto that a gaseous or liquid jet vibrates under the influence of a limited range of tones only, effective tones being those which do not differ greatly in pitch from the normal or proper tone of the jet discovered by Savart and Sondhauss. The author has found, however, that when the pressure under which a jet escapes is not too great, the latter is affected by all tones lower than the normal, as well as by some above it. Changes may be excited in a jet of either kind by vibratory motions of the jet orifice, or of the fluid behind, or external to the orifice. These changes take the form of slight swellings and contractions, which become more pronounced as the fluid travels away from the orifice, and finally cause the jet to break or become discontinuous at a distance which depends upon the intensity of the initial disturbances. At any point within the continuous portion of the jet the successive swellings and expansions represent both the form and the relative intensities of vibrations impressed upon the orifice; and the jet is therefore capable of reproducing very complex sounds, such as those of speech and music.

A vibrating jet of air does not, however, emit sound when it plays into the air, or into the wide end of a tube communicating with the ear; but when it plays against a very *small* orifice in the end of a hearing-tube, loud sounds may result. This reproduction is most intense when the hearing orifice is placed in the axis of the jet, just within the breaking point, but becomes gradually feebler as the hearing orifice is moved towards the jet orifice, or out of the line of its axis. Beyond the breaking point the sounds from the jet at first become confused, and finally are lost.

A jet of gas, like a liquid jet, only vibrates so as to produce its normal tone when it strikes upon some obstacle which serves to diffuse the disturbances due to impact, or throw them back upon the orifice. The vibrations of an air jet are also loudly reproduced as sound, when it is directed against a small flame below the apex of the blue zone.

Liquid jets are but slightly sensitive to aërial sound impulses, but become highly sensitive when the jet tube is rigidly attached to a sound-board. The vibrations of a jet so mounted are best perceived as sound when the stream strikes upon a rubber membrane tied over the end of a narrow tube which communicates with the ear. For accurate reproduction of speech and sounds in general, the jet should be at such a pressure as to respond visibly to a note of about 4000 vibrations per second, and the membrane should be at such a distance from the orifice that the jet never breaks or becomes discontinuous above its surface.

The vibrations of very fine jets of any conducting liquid become loudly audible when a portion of the jet or the "nappe" formed, when it strikes upon a flat surface, is included in circuit with a battery and a telephone. This may be accomplished by letting the jet impinge on the end of an ebonite rod, through the centre of which passes a platinum wire: the upper end of the rod is surrounded by a short tube or ring of platinum, the upper margin of which forms a continuous, slightly convex surface with

the exposed end of the central wire and the ebonite. The wire and ring form the terminals of the circuit which is completed through the nappe. Distilled water, containing 1-300th of its volume of pure sulphuric acid, is recommended as the jet liquid.

The author advances a new theory to account for the growth of the vibratory changes in liquid and gaseous jets.

"*On some Thermo-dynamical Relations.*" Part V. By Prof. W. RAMSAY and Dr. S. YOUNG.

In Parts I. and II. of this series of papers it was shown that the ratio of the absolute temperatures of any two bodies corresponding to a given vapour-pressure bears a simple relation to the ratio at any other pressure, which may be expressed by the equation $R' = R + c(t' - t)$, where R' and R are the two ratios, c is a constant, and t' and t are the temperatures of one of the two bodies. The determination by Schumann (*Pogg. Ann. N. F.*, xii., 46) of the vapours of methyl formate and twenty-seven homologous ethers made it possible to compare the vapour-pressures of a large number of bodies belonging to the same class. It was found that when the ethers were compared with ethyl acetate, which was taken as the standard, in every case $c = o$, and therefore $R' = R$. The temperatures corresponding to the then pressures, 200, 760, and 1300 m.m., are given by Schumann. Taking the mean value of R for those pressures as correct, and re-calculating the temperatures, the greatest difference between the found and re-calculated temperatures is 0·7° C. The vapour-pressures of water, or any one of the ethers, being accurately known, it is sufficient to determine the boiling-point of any ether belonging to this class in order to construct its vapour-pressure curve. The absolute temperatures corresponding to the pressures 200 and 1300 m.m. for any ether are $0{\cdot}89795\ t$ and $1{\cdot}0488\ t$, where t is the boiling-point at normal pressure in absolute temperature.

A gridiron slide rule, by Mr. Stanley, designed by Mr. Thacher, was explained by Mr. C. V. Boys. It was equivalent to a slide 60 feet long, and performed multiplication and division with an error not exceeding the 1-40,000th part.

Specimens of safety explosives, and their results in shattering blocks of lead, were exhibited by H. Sprengel.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, February 23, 1886.

Prof. W. C. WILLIAMSON, LL.D., F.R.S., President, in the chair.

"*Preliminary Note on a New Method of rapidly determining the total Organic Carbon in Waters.*" By CHARLES A. BURGHARDT, Ph.D.

Hitherto all the methods recommended for water analysis, and particularly those which are most generally adopted by chemists, have failed to give the *total* organic carbon present in a polluted water. The method known as Frankland's is the principal one which has hitherto claimed to actually ascertain the amount of organic carbon and nitrogen in a water. This process of Frankland's necessitates a preliminary evaporation of the water to dryness, and I have no hesitation in saying that on this account it cannot any longer be relied on to give, even approximately, the amount of organic carbon present in a polluted water, because I have found in the course of numerous analyses of the water of the River Irwell and its tributaries, that a very large quantity of the organic matter in such polluted water exists in such a condition that a rise in the temperature to 100° C. caused it to decompose and be evolved in the form of carbon dioxide gas; consequently, during the evaporation to dryness, as in most methods of water analysis, this organic matter is lost and not taken into account at all. There is no doubt that in highly polluted streams the amount of carbon dioxide gas *in solution* is an index to the amount of pollution by sewage and manufacturers waste-waters. The water of the River Irwell is almost *saturated* with carbon dioxide gas at the temperature of the air. I have often proved that this carbon dioxide gas must be derived from the organic matters in the water, by determining the amount of *dissolved* carbon dioxide in a sample, and then keeping the same sample for several weeks, and ascertaining how much of the gas was dissolved in it, at intervals of a week, with the same result in all cases, viz:—*a further increase in the amount of carbon dioxide gas dissolved in the water.* This proves that the organic matter is easily decomposed into gaseous products; consequently it becomes a great difficulty how to ascertain the total organic carbon in a sample of polluted water.

About August, 1884, I first applied a slight modification of Ulgren's well-known method for determining the amount of carbon in steel, to water analysis.

The process is as follows:

Take an eight oz. or twelve oz. flask, fitted with a syphon funnel tube passing to the bottom of the flask, a thermometer, and an exit tube passing out of the flask into the bottom of a 4 oz. flask containing 50 c.c. of a standard solution of calcium hydrate, and an exit tube from this last flask passing to the bottom of another 4 oz. flask, also containing 50 c.c. of calcium hydrate solution. The exit tube from this last flask is connected with a small tube containing small pieces of caustic soda, to absorb any carbon dioxide gas which might otherwise get into the calcium hydrate flask from the air.

Place in the large flask 250 c.c. of the water sample, connect all the flasks, and fill partially the funnel tube with water, so that the pressure of the air at the end of the apparatus is overcome, and sucking back prevented. Now surround the flask with a water-bath, and heat the water in the flask to about 94° C., when the dissolved carbon dioxide is at once evolved and absorbed by the standard calcium hydrate solution in the small flasks. In a quarter of an hour or so these flasks are detached, the water-bath removed from the large flask, and the excess of calcium hydrate remaining in the flasks determined by titration with decinormal oxalic acid solution (using aurine as an indicator). The small flasks are then cleaned out and re-charged with the known volume of calcium hydrate solution as before, and the large flask containing the water heated by the bare flame of an ordinary Bunsen lamp, and the contents boiled until the steam—passing into the first small flask—heated the same to nearly boiling-point; at this stage the small flasks are disconnected, and the lamp removed from the large flask, the titration of the calcium hydrate in the flasks being repeated, ahd the amount of carbon dioxide thus evolved by the *decomposition of the organic matter* determined. Dilute sulphuric acid (about 20 c.c.) is now poured into the funnel tube and so into the large flask, the small flasks re-charged with calcium hydrate and connected to the large flask as before, and the latter again boiled with the bare flame of the lamp as in the last determination. The carbon dioxide obtained in this stage is mostly that derived from carbonates of calcium and magnesium in the water. I now take 5 grms. of crystallised chromic acid, or an equivalent amount of potassium bichromate, and dissolve it in 20 c.c. of strong sulphuric acid, and pour this mixture through the funnel tube into the flask, and repeat the operations as before. *The carbon dioxide evolved in this stage is derived entirely from organic carbon* present in the water.

I have tested this method with the Irwell water and obtained as much as 2·7 grains per gallon of carbon in the last stage, and 0·4118 grains of carbon altogether in the first and second stages. I have also tried it with a known weight of perfectly pure sugar, and obtained almost absolutely the theoretical amount of carbon. I hope to pub-

lish at an early date some of the analytical results obtained, and give at the same time comparative analyses by Wanklyn's and Tidy's methods. Until quite lately I have not been able to work out the process described above to a satisfactory termination.

Ordinary Meeting, March 9, 1886.

Prof. W. C. WILLIAMSON, LL.D., F.R.S., President, in the chair.

"*Note on Apparatus for Photographing the Moon.*" By A. BROTHERS, F.R.A.S.

About twenty years ago I read before the Photographic Section of this Society a paper on *Celestial Photography*. The paper contains a description of a piece of apparatus which I contrived and adapted to a telescope, so as to dispense with a camera in photographing the moon or other celestial objects. As I have recently been asked by Mr. E. G. Loder to obtain for him one of these instruments, and as there are some improvements introduced, and probably no member present has seen the apparatus, I have brought it for inspection.

When the eyepiece of a telescope is removed the image of the moon can be brought to a focus on a piece of ground glass in the same way as in an ordinary camera, and a picture could be taken on a plate held in that position. But as the process of taking single pictures is tedious, and as the area of the plate covered by the image is limited, it is possible to take four or more pictures on one plate. This little piece of apparatus is arranged for taking four pictures on a 5×4 plate. The great advantage of this plan of proceeding is that four different exposures may be obtained in very little more time than is required to take one; and this is important, as it enables the operator to select the one which appears nearest to being correct as a guide for subsequent work on the same evening.

With all telescopes, excepting reflectors, there is the difficulty of the chemical focus to overcome, and many failures arise in correcting this.

The only advantage in using a telescope in photographing the moon is that the length of focus gives a large image; but for photographing the stars the field is too limited, and the time of exposure is of course long. It was in order to obtain a large field that I used a camera and photographic lens in photographing the eclipse in 1870. This method has been followed on every occasion of an eclipse since; and I am glad to notice that in the very important work now being carried on in various observatories for photographing the stars the same plan is adopted. The introduction of gelatin plates has greatly facilitated the work of photographing the stars and other faint objects, but so far as my own observation extends the whole of the best eclipse work and the photographs of the moon have been done by the old collodion process.

Ordinary Meeting, March 23, 1886.

Prof. W. C. WILLIAMSON, LL.D., F.R.S., President, in the chair.

"*On the Determination of the Calorific Power of Fuel by Direct Combustion in Oxygen.*" By WILLIAM THOMSON, F.R.S. Ed., F.C.S.

Having been engaged some time ago with determinations of the heating power of various samples of coal by the apparatus devised by Mr. Lewis Thompson, M.R.C.S., I was struck by the unsatisfactory nature of the process, which consists in mixing intimately 2 grms. of coal with 22 grms. of a mixture of 3 parts of chlorate and 1 part of nitrate of potash. This mixture is placed in a small copper tube, and ignited by a fuse prepared by soaking two or three strands of ordinary lamp wick in nitrate of potash solution and drying. About three-quarters of an inch of this fuse is placed upright in the mixture, the tube containing which is put on a stand, surrounded with four upright brass springs (strips of brass fixed to the stand at the bottom and curved upwards and inwards).

The fuse is ignited, and smoulders slowly down to the coal and oxygen mixture. In the meantime a cap or cylinder of copper closed at the top (to which is attached a narrow copper tube furnished at the end with a stop-cock) is placed over the copper tube containing the coal, chlorate, and nitrate mixture by pushing it over the springs which serve to keep the copper cylinder in its place. The whole apparatus is now lifted by the narrow copper tube and immersed in a glass cylinder about 13¼ in. long by 4½ in. wide containing a large quantity of water (preferably either 2000 or 1934 c.c.), the temperature of which has been accurately taken by a delicate thermometer. The mixture ignites and burns away like a squib, the hot gases bubbling through the water, to which it parts with its heat. When the combustion is complete the stop-cock at the end of the narrow copper tube is opened to allow the residual gas in the apparatus to escape and to allow the water to take up the heat still retained by the copper tube and by the salts left from the combustion. It is admitted that even with the most careful use of this apparatus it is impossible to obtain accurate results, because there are so many sources of error. First, the chlorate of potash in becoming dissociated into chloride of potassium and oxygen liberates a considerable quantity of heat; the nitrate of potash, on being decomposed, absorbs heat; the oxygen, on being liberated from the solid condition and expanding to the ordinary pressure of the air, absorbs heat; and there is a further error introduced by the combustion of the copper of the tube—the tube, becoming heated to bright redness, becomes covered with a scale of the oxide; and, last of all, the potassium chloride remaining from the combustion absorbs a considerable quantity of heat in dissolving. Mr. Lewis Thompson recognised that his process did not register the total quantity of heat produced, and he says it is necessary to add 10 per cent to the result obtained. According to Mr. Thomas's experiments, if the coal be of a graphitic nature the chlorate and nitrate mixture will not burn it completely; yet the process is employed by the Italian Government as a test, and by railway and other companies in England. I have further found it difficult to obtain concordant results from this process with the same coal tested at different times.

The process which I have devised consists in burning the coal in oxygen. In a short communication which I brought before the Physical and Mathematical Section of this Society on the unsatisfactory nature of Lewis Thompson's process, our excellent Vice-President, Dr. Joule, suggested the idea to me of burning the coal in pure oxygen. I endeavoured to accomplish this in many different ways, but failed, a certain amount of unconsumed carbon, under some conditions, being liberated which adhered to the sides of the vessel containing the oxygen, whilst under other conditions the carbon consumed very slowly and usually imperfectly, leaving some unconsumed carbon behind. I ultimately succeeded in completely consuming the coal within a few minutes, and measuring the heat produced therefrom by the apparatus and method which I give, as follows.

I took the ordinary stand, with brass springs attached, which was used for the Lewis Thompson apparatus. In it I fitted the bowl of an ordinary clay tobacco pipe, rather less than ¼ in. internal diameter by 1½ in. long. This I used as a stand for a small platinum crucible ¼ in. diameter by 1½ in. long, because the clay is a non-conductor of heat and would not injure the platinum, when heated to redness. Into this platinum crucible I introduced 1 grm. of coal in a fine state of division, which was ignited, after being placed on its stand, by a fuse such as that used by Mr. Lewis Thompson, and the whole covered by an inverted wide glass test-tube 6 in. long by 1½ in. diameter, to the bottom of which was

attached a piece of narrow tubing 1 in. long by ⅛ in. in diameter. Over this tube was drawn a piece of india-rubber tubing, the free end of which was turned over on itself, and through this rubber was passed a glass or thin copper tube (preferably the latter) terminating with a stop-cock.

When the fuse is ignited the mouth of the test-tube is pushed over the brass springs, thus enclosing the platinum crucible containing the coal, on the diving-bell principle, and the whole is then sunk into the cylinder, containing either 1934 or 2000 grms. of water, the temperature of which has previously been taken by a delicate thermometer. A stream of oxygen from a gas holder or gas bag is then allowed to flow slowly through the test-tube downwards, making its escape at the mouth and bubbling through the water. It is necessary to commence the combustion by having the movable tube which penetrates the bottom of the test-tube drawn well up so as to have a complete atmosphere of oxygen in the test-tube until most of the volatile matter of the coal is consumed. The movable tube is then gradually pushed down till it comes to the mouth of the platinum crucible; a slow circular movement is then given to it by the hand till the whole of the fixed carbon of the coal is consumed, which is rapidly done under the stream of oxygen impinging on it. The ash is then left as a number of fused globules, many of them adhering to the crucible, having been completely fused by the intense heat of the combustion. The water is then allowed to enter the tube and come in contact with the hot crucible and tobacco-pipe support and entrance tube for the gas, to abstract the heat left in them; the whole of the water is then well mixed and the temperature again taken, the difference between the two temperatures being the heat given to the water by the combustion of the coal. I have found that the temperature of the water is practically not altered by passing about three gallons of air or oxygen through it, that being in excess of the quantity required to burn the coal, between 1½ and 2 gallons being actually required.

By this method it is not necessary to deduct or add to the result obtained. It is more convenient than Lewis Thompson's method, inasmuch as it is not necessary to have the coal in such a fine state of division, whilst the drying and weighing out of the nitrate and chlorate of potash, and incorporating the coal with them, is dispensed with, and when care is taken the results obtained by a series of experiments on the same coal is the same for each experiment. The rise for each grm. of good coal is somewhere about 6 to 7 degress Fahrenheit for the 1934 grms. of water, that being equivalent to about 11,500 to 13,500 units of heat.

Graphite burns away quite easily in the oxygen apparatus.

During the time the experiment is being made I find it necessary to have the cylinder containing the water resting on three pieces of cork in a loosely fitting vessel of bright tinned iron plate, having a slit 7 in. long and 1 in. wide cut down one side, through which the combustion can be observed. This vessel practically prevents loss of heat from the water if it is above the temperature of the surrounding air, and *vice versâ* if the temperature of the water be lower than that of the air, but I prefer to have at hand a large supply of water which has been exposed to the atmosphere for some hours, in order that its temperature may become as nearly as possible the same as that of the air.

Certain Double Silicates of Aluminium and Potassium or Sodium.—Al. Gorgen.—The author has examined the action of kaolin upon the alkaline haloid salts, upon alkaline carbonates, and caustic alkalies. The results obtained with the caustic or carbonated alkalies explain in what manner these reagents act upon aluminium silicates, transforming them into a mixture of silicate, aluminate, and double salts.—*Comptes Rendus.*

NOTICES OF BOOKS.

Notes on Analytical Chemistry for Students in Medicine. Extracted from the Fifth Edition of "Notes for Students in Chemistry." By A. J. Bernays, Ph.D., F.C.S., F.I.C. London: J. and A. Churchill.

The author tells us, in his Preface, that in remodelling the sixth edition of his "Notes for Students in Chemistry," want of space compelled him to eliminate the "Notes on Analysis," which had previously formed part and parcel of that work. He accordingly published them independently in 1879, and he now places before the public a second and extended edition.

We learn further, from the Preface, that the object of this work is essentially examinational. The author "trusts and believes that these analytical notes will be suitable for students at all ordinary examinations." In other words, Dr. Bernays' chief concern is to enable students to "pass,"—certainly not the highest aim.

Conciseness of language has been carried to a very great length, though falling short of obscurity. We notice a few peculiar expressions: thus we read that certain substances "combust." In the section on volumetric operations we find the term deci-equivalent substituted for the familiar "decinormal."

We notice with satisfaction that Dr. Bernays considers the estimation of phosphates in waters as of great importance, and declares that "in a surface water they certainly point to sewage contamination." The presence of potassium salts in water he also regards as a bad sign. Generally speaking, we certainly should agree with him in both these conclusions; still, surface waters draining from lands which have been manured with superphosphate, especially if calcareous matter be deficient, may contain an appreciable quantity of phosphoric acid in the entire absence of sewage contamination. Potassium salts may, in a corresponding manner, be introduced into surface waters by means of kainite, which is now somewhat widely used as a manure.

The author, very justifiably, dissents from the view that nitrates present in water necessarily indicate previous sewage contamination, since they may be geological in their origin.

The section on ultimate organic analysis is far too brief to be of any practical value.

In the notice of the "periodic law" we are very glad to perceive that due honour is given to Mr. Newlands.

There are certain omissions perceptible in the work before us, but, considering how much matter has had to be compressed within some one hundred and twenty pages, the wonder is rather that they are not more numerous.

Notes on the Corrosion of Iron and Steel, and Means adopted for their Preservation and Protection, with Special Reference to the Protection of Iron and Steel Ships. By T. H. Davis, F.I.C. Liverpool: Tyerman.

This pamphlet deals with a question of very great importance to our country. An immense yearly loss is experienced, both in the Royal Navy and the Mercantile Marine, from this one cause, corrosion, or, chemically speaking, oxidation. This oxidation, as theory would inform us, and as actual experience, here quoted, shows, goes on the more rapidly the higher the quality of the iron.

We learn, from the report of Lloyd's chief engineering surveyor, that "the rate of corrosion of high-class Yorkshire plates amounts to 9·4 per cent more than common iron, and *mild steel 40 per cent more.*"

In painting, as an antidote to corrosion, the author has little faith—at least as it is commonly practised. He suggests that the oil used, generally linseed oil, is not a protective, but very probably assists the rapidity of oxidation. This we shall think the more likely if we reflect

that most of the oils of commerce contain a noteworthy proportion of free fatty acids. Caustic alkali, the author admits, suspends the corrosion, but how is an alkali applied to a ship's bottom to be kept at once from washing off and from taking up carbonic acid from the sea-water?

Mr. Davis goes on to show that no trustworthy coating has yet been invented, or else that the conditions in different seas vary, so that what is useful in one part of the world may be elsewhere useless or even hurtful. Against red-lead paint he protests on good grounds. Iron when in contact with lead is rapidly destroyed. Besides, the men in large dockyards, who are frequently employed in scraping lead paints off vessels and re-painting them, suffer severely from lead-poisoning.

The author thinks that black varnish or boiled coal-tar, if freed from ammonia and sulphuretted hydrogen, "approach very nearly the typical paint for iron-work."

We may here raise the question whether a paint made from red oxide of iron would not at least be much preferable to red lead? We know that such iron-paint has been successfully used for the hoops of casks in which iron mordants, such as black liquor and nitrate of iron, are stored up or sent out.

Of the anti-fouling paints, which are to prevent the adhesion of barnacles and sea-weeds by means of some poisonous mineral salt, he forms but low estimate. The organisms in question are found in quantity adhering to compounds of this character. Besides, the salts of arsenic, antimony, and mercury employed are often decomposed and the metals deposited on the iron, setting up destructive galvanic actions.

The conclusion arrived at is conveyed in the words—"Let ship-owners insist on the best of cleaning and painting, using their best judgment and care in choice of the composition to be employed, inclining to those which dry with a smooth, hard surface, depending on a scientific anti-fouling property, and containing no decomposable mineral poisons."

It is to be hoped—and such is evidently the author's wish—that this subject may attract study and research. The misfortune is that private firms and companies, just like governments, have their "circumlocution offices," and insist on seeing with the eyes of some interested official. Thus invention is discouraged.

Report by Prof. Wrightson and Dr. Munro, of the College of Agriculture, Downton, Salisbury, on Experiments made by them to Test the Manurial Value of the Basic Cinder made at the Works of the North-Eastern Steel Company, Limited, Middlesborough. Middlesborough: "Daily Exchange" Office.

Among the results of the Thomas-Gilchrist process not the least important is that a very large quantity of phosphoric acid, formerly neglected, is made available as plant-food. The cinder or slag actually used contained 14·32 per cent of phosphoric acid, though the North-Eastern Steel Company are now producing a cinder containing 16 to 19 per cent of phosphoric acid.

The cinder, finely ground, was tried against ordinary superphosphate, containing 26 to 28 per cent soluble phosphate, against a rich Curaçoa superphosphate containing 44 to 45 per cent soluble phosphate, and ground Cambridge coprolites containing 55 per cent tricalcic phosphate. The experiments were made at Downton on a light, thin, chalky soil, and at Ferryhill, Durham, on a stiff deep clay which was almost destitute of lime.

The result showed that the raw, ground basic cinder has a very considerable manurial value, and that it pushes on the young turnip and Swede plants beyond the reach of their enemy, the "fly." An average dressing of ½ ton cinder per acre more than doubled the crop at Downton, as compared with the adjacent unmanured plots, and more than quadrupled it at Ferryhill.

It is remarkable that ground cinder containing 14·3 per cent of phosphoric acid gave better results than an equal weight of ground coprolites containing 25 per cent of phosphoric acid. Hence the authors draw the very natural conclusion that the phosphate in the cinder is in a more assimilable condition than that in coprolites.

The phosphoric acid in cinder is, however, not so easily assimilated as that in soluble phosphates, the difference being less in this respect on the clay than on the chalk.

Various mixtures of raw cinder and superphosphate have been tried and patented. The cinder is specially recommended as a "drier" for superphosphates, and as a precipitating agent for the phosphoric acid of superphosphate.

A kind of superphosphate, "ferrous superphosphate," made from basic cinder and patented, has also been tried.

On the clay soil the authors consider that the best dressing is 4 cwts. raw ground cinder per acre, whilst at Downton the best proportions range from 10 to 20 cwts. per acre.

This pamphlet must be regarded as a valuable contribution to agricultural chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cii., No. 20, May 17, 1886.

Observations relative to the Determination of Ammonia in the Soil; a Reply to M. Schlœsing.—MM. Berthelot and André.—The authors do not contest the experiments of M. Schlœsing, but they do not consider that these prove the absorption of ammonia by the soil from the atmosphere. They show merely a progressive enrichment in ammonia of a dry earth exposed to the contact of the air during the months of August and September, whilst moist earth retains very little. But they throw no certain light on the origin of this ammonia. They recommend that the ammonia of a soil should be determined immediately after the sample is taken, and without previous drying.

Atomic Volume of Oxygen.—E. H. Amagat.—Referring to M. Wroblewski's announcement that the atomic volume of oxygen is decidedly inferior to 16, the author points out that in his communication of March 2, 1885, he drew the same conclusion from his experiments. Under a pressure exceeding 4000 atmospheres he succeeded in obtaining oxygen with a density exceeding 1·25 at the temperature of 17°. M. Wroblewski by refrigeration alone has succeeded in obtaining for the same body at −200° a density equal to 1·24. It is probable that by combining the action of cold and pressure we might arrive at a much higher figure, and consequently at a lower atomic volume. In this case we might admit, with Dumas, that sulphur, selenium, and tellurium may have the same atomic volume, whilst that of oxygen (which, moreover, occupies a separate position in this family) would bear a simple relation with the other three, probably as 1 : 2. In these conditions the form which the branch of L. Meyer's curve would take indicates for fluorine an atomic volume the half of those of chlorine, bromine, and iodine.

Action of Vanadic Acid upon Ammoniacal Salts.—A. Ditte.—Ammoniacal salts brought in contact with vanadic acid may act in three different manners: 1. Vanadic acid is capable of uniting with the salt in question,

forming the ammoniacal salt of a complex acid; 2. The vanadic acid decomposes the ammoniacal salt, forming an acid salt and an acid ammonium vanadiate, always a trivanadiate on operating at a boil; 3. Lastly, vanadic acid is without action upon the ammoniacal salt, as in the case of ammonium nitrate.

Combinations of Zinc Chloride with Water.—R. Engel.—The author describes three compounds, the first containing 3, the second 2 mols. of water, whilst the third contains 2 mols. of zinc chloride to 3 of water.

Compound of Hydrogen Phosphide with Chloral Hydrate.—J. de Girard.—The author has previously obtained dichloral-phosphine, a compound consisting of 1 mol. hydrogen phosphide combined with 2 mols. anhydrous chloral. He has now succeeded in preparing a corresponding compound with chloral hydrate, and has examined some of its derivatives.

On Pilocarpine.—E. Hardy and G. Calmels.—The authors have established the constitution of this compound and have examined its derivative, pilocarpidine.

Researches on the Composition of Carotine, its Chemical Function, and its Formula.—A. Arnaud.—Carotine is rapidly oxidised by the air even at the ordinary temperature, and especially about 70°. During this change the blue solution of carotine passes into a violet and finally into a brick-red. The oxidised product contains 21 per cent of oxygen, and does not possess the properties of carotine. It is incapable of crystallisation. Carotine is a non-saturated hydrocarbon.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 8, April 15, 1886.

The Ptomaines and the Leucomaines.—(Continued).—Armand Gautier.—In this paper the author describes the muscular leucomaines, xanthocreatinine, crusocreatinine, amphicreatinine, and pseudoxanthine. In summing up his results the author adds that along with the animal alkaloids there exist other nitrogenous substances which are not alkaloids, but which have a still greater activity. The septic poison of panum contains no alkaloids; the nitrogenous matters extracted from urine are highly toxical, and the author is convinced that the essentially active portion of serpent poisons, though nitrogenous, is not alkaloidal.

A Ptomaine extracted from Poisonous Cheese.—V. Vaughan.—The poison in question, turotoxicon, forms acicular crystals. It reduces iodic acid and does not precipitate the ordinary reagents for alkaloids. If exposed to the air the crystals are destroyed, leaving an acid product. They are soluble in water, alcohol, and ether.

Electrolytic Determination of Mercury.—Don Luis de la Escosura.—(See p. 249).

Presence of Roccelline Red in Saffron.—MM. Cazeneuve and G. Linossier.—The authors detect this fraud by comparative dyeing experiments. They consider that roccelline red is less dangerous than jaune d'or (sodium binitronaphthol) and sodium dinitrocresylate.

Essential Oils of the Aurantiaceæ.—Ch. Noel.

Potable Waters of Compiègne.—H. Priou.—The author has examined a number of specimens of well and river waters from the district of Compiègne, determining hardness, sulphuric acid, and lime, chlorine, oxygen, organic matter, organic nitrogen, and ammonia. Nitric nitrogen and phosphoric acid have not been determined. According to M. Marié-Davy (*Journal d'Hygiène*) the ammonia falls from 29·2 grms. in the sewage of Paris to 0·7 grm. in the drain of Asnières. The albumenoid ammonia falls in like manner from 2·8 grms. to 0·3 grm., whilst the nitric nitrogen rises from 1 grm. to 24·3 grms.

Poisonous Principles of Mussels.—M. Brieger.—The author has obtained from these molluscs, 1, a non-poisonous substance; 2, a substance which is isolated by means of platinum chloride, and which produces energetic salivation and diarrhœa; 3, the specific virus, which combines only with the tetrahedral platinum chloride. It possesses the characteristic properties of curare; 4, an analogous body, probably a decomposition-product. It is an energetic poison and occasions shiverings. The two last-mentioned bodies seem to be ptomaines. Non-poisonous mussels, if brought in from the offing and deposited in the harbour, become poisonous, but lose this property again if returned to the open sea. (Is the development of the poisonous principles occasioned by the mussels feeding upon sewage-matters?)

Therapeutic Use of Hydrated Zinc Sulphide.—Pierre Vigier.—This paper has no chemical interest.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 9, May 5, 1886.

Density Pipette.—L. Amat.—This apparatus cannot be intelligibly described without the accompanying figure.

The Bitter Principles of the Hop.—H. Bungener.—The author rejects the common view that the resin of the hop-cones is the bitter principle. This resin is insoluble in water, but a decoction of hops made with distilled water is quite as bitter as a decoction of malt in which an equal quantity of hops has been boiled. M. Bungener shows that the crystalline acid, first obtained in an impure state by Lermer, is really the bitter principle. This lupulic acid is insoluble in water, but its oxidation-product dissolves rapidly in water, with the aid of heat, imparting to it an intensely bitter taste.

Action, in the Cold, of Alcoholic Chlorides upon Ammonia and Methylic Amines.—C. Vincent and J. Chappuis.—This paper requires the accompanying illustration.

A New Ureometer.—The construction and the use of this instrument cannot be rendered intelligible without the annexed cut.

On Some Xylenic Derivatives.—A. Colson and H. Gautier.—The authors describe the ortho-, para-, and meta-xylene perchlorides, the terephthalic, orthophthalic, and metaxylenic aldehydes, and orthophenylene-glyoxylic acid.

Action of Aluminium Chloride upon the α-Bromo-, Chloro-, and Iodo-naphthalines.—When aluminium chloride reacts upon α-monobromo-naphthaline there are produced naphthaline, α-monobromo-naphthaline, undecomposed β-monobromo-naphthaline, a small quantity of dibromo-naphthalines, and black tars which cannot be distilled. The same reagent, acting upon α-monochloro-naphthaline yields a small quantity of naphthaline, black tarry matters, and β-monochloro-naphthaline. With α-monoiodo-naphthaline the products are naphthalene, free iodine, and tars which cannot be distilled.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. xix., No. 3.

Propyl Group in the Cumin and Cymol Series.—O. Widmann.—Isopropyl passes in the following cases into normal propyl; cuminic alcohol, on boiling with zinc-powder passes into ordinary cymol. Cumyl chloride, if boiled with zinc-powder and hydrochloric acid, yields ordinary cymol. Nitrocymylenchloride, on boiling with zinc and hydrochloric acid, passes into normal cymidine. On the other hand, normal propyl is converted into isopropyl in the following cases: ordinary normal cymol in passing through the animal organism is oxidised to cuminic acid; cymol is converted into cuminic acid on agitation with

soda-lye and air; normal cymol-sulphonic acid on oxidation with potassium permanganate in an alkaline solution, yields oxy-isopropyl-sulphobenzoic acid. Cymol, on heating with permanganate in a strongly alkaline solution, yields oxy-isopropyl-benzoic acid. Thymol, on fusion with potassium hydroxide, is converted into the same oxycuminic acid which Lippmann and Lange obtained by the action of nitrous acid upon meta-amidocuminic acid. Carvacrol, which contains normal propyl, passes, on fusion with potassium hydroxide, into an oxycuminic acid, probably the ortho-variety.

New Researches on Diazo-compounds.—(Twelfth communication).—P. Griess.—The author describes the decomposition of diazo-benzolimide with hydrochloric acid, the decomposition of the same compound with sulphuric acid, the decomposition of meta-diazobenzoic-imide with hydrochloric acid, chlor-amidobenzoic acid sparingly soluble in cold water, the modification more easily soluble in cold water, and, secondly, the action of nitrous acid upon aromatic diazo-compounds, including the meta-bidiazobenzol compounds, meta-tetrazobenzol platinum chloride hydrochlorate, and meta-tetrazobenzol-auric chloride hydrochlorate.

Applicability of Hydrogen Peroxide in Volumetric Analysis.—S. Eliasberg.

Electrolytic Quantitative Analysis. — A. Classen and R. Ludwig.—These two papers will be inserted at some length.

Coccerine from Living Cochineal.— C. Liebermann. —The author has had the opportunity of examining the peculiar wax of the cochineal of commerce as found on the unprepared living insect.

Synthesis of Oxy-anthraquinon from Meta-oxybenzoic Acids and Benzoic Acid.—C. Liebermann and St. von Kostanecki.—Both mono-oxy-anthraquinons are formed, but accompanied by three isomeric dioxy-anthraquinons. The separation of oxy-anthraquinon and benz-bioxy-anthraquinon is effected by means of their acetyl-compounds.

Synthesis of Xanthopurpurin and Purpurin.— E. Noah.—The author mixes 1 part symmetric dioxybenzoic acid, 5 parts benzoic acid, and 5 parts sulphuric acid. The mixture is heated to 105° to 110° in the oil-bath for seven hours. Xanthopurpurin is obtained from the mass by repeated extraction with ether. Xanthopurpurin is converted into purpurin by fusion with solid potassa and a little water.

Behaviour of Nitrised Acetanilides and Naphthalides with Alkali.—Kleemann.

Nitroso-naphthols and Certain of their Derivatives. —M. Ilinski.—These two extensive memoirs do not admit of useful abridgment.

On Dinitroso-naphthaline.—M. Ilinski.— This compound is insoluble in water, sparingly soluble in cold alcohol, hot ligroin, and ether, readily soluble in hot benzol, from which it is precipitated by ligroin in fine needles. The compound is readily volatile along with watery vapour, and it dissolves in strong sulphuric acid with a yellow colour.

Azopianic Acid and a New Derivative of Indigo. C. Liebermann.—On the nitration of opianic acid the nitro-group really assumes the ortho-position with reference to the aldehyd-group. The new compound is an indigo which contains the substituting groups of opianic acid.

Certain Reduction-Products of Aromatic Aldehyds.—Fr. Tiemann.—It appears that benzaldehyd on the one hand and salicylaldehyd and para-oxy-benzaldehyd on the other behave in an essentially different manner when treated with zinc powder and glacial acetic acid. The first mentioned is easily reduced to benzyl alcohol and then converted into benzyl-acetate. In the two latter the reduction extends only to the formation of hydrobenzoine-like substances.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 3, March, 1886.

Purification of Ammonium Hydrochlorate.—This compound is one of the by-products extracted from the residual liquors of the ammonia-soda process, but it is always mixed with sodium chloride, which, as an impurity, reduces its value. M. Solvay separates the two products by evaporating the liquid to dryness and expelling the ammonium hydrochlorate by heating to the requisite temperature. The residual salt is then heated in a retort with the addition of some inert matter to distribute the heat more uniformly. Finally the ammonium hydrochlorate is volatilised by injecting a current of superheated steam.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Testing Fire-Clay.—I should be much obliged to any correspondent who would inform me of the most simple and safe method of testing fire-clay for glass-house pots, tanks, furnaces, &c.—AN OLD SUBSCRIBER.

MEETINGS FOR THE WEEK.

MONDAY, 7th.—Royal Institution, 5. General Monthly Meeting.
TUESDAY, 8th.—Royal Institution, 3. "The Function of Circulation," by Prof. Arthur Gamgee, F.R.S.
—— Photographic, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Society of Chemical Industry, 8. "The Chemical Treatment of Sewage," by Dr. C. Meymott Tidy.
WEDNESDAY, 9th.—Geological, 8.
—— Microscopical, 8.
THURSDAY, 10th.—Royal Institution, 3. "Habit as a Factor in Human Morphology," by Prof. A. Macalister, F.R.S.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
—— Mathematical, 8.
FRIDAY, 11th.—Royal Institution, 9. "Meteorite Problems," by Prof. Dewar, F.R.S.
—— Astronomical, 8.
—— Quekett, 8.
SATURDAY, 12th.—Royal Institution, 3. "Light, with special reference to Effects resulting from its Action on various substances," by Prof. Stokes, Pres. R.S.
—— Physical, 3. "On Electric Light Fire-Damp Indicators," by Messrs. W. Emmott and W. Ackroyd.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1385.

NOTE ON THE BLUE COLOURING-MATTER OF DECAYING WOOD.

By SAMUEL RIDEAL, B.SC., F.C.S.

The wood from which the colouring-matter experimented with has been extracted was found in the neighbourhood of Aviemore, Inverness-shire, in different parts of the forest of Rothiemurchus, but in most cases it was so decomposed and decayed as to render its identification difficult. One piece, however, was obtained with the bark attached, and with the blue colour well developed throughout the wood, which was easily recognised as being the wood of *Betula alba*. In the localities in which the specimens were found the birch tree was especially abundant, and no Coniferæ were observed in the immediate neighbourhood; so that, although the blue colour has not been found in the growing birch, there is good reason for believing that all the specimens collected were pieces of the decayed wood of this tree. Girdwood and Bemrose (*Brit. Assoc. Reports*, 1884) have shown, in some preliminary notes on a blue colouring-matter found in certain wood undergoing decomposition in the forests of Canada, that a similar colouring-matter is developed in the decaying wood of the balsam pine (*Abies balsamea*). All their specimens were found lying on the ground, and never in standing trees; and although they did not succeed in obtaining any specimens with the bark attached, yet, from the microscopical character of the wood, and from several knots and fragments of roots, they inferred that the wood must be that of the Canadian balsam. From the fact that the colouring-matter apparently begins to form in the sap-wood, and from its solubilities and insolubilities, they conclude that it may be a result of the decomposition of the balsam in the outer layer of the woody tissue. The formation of balsam appears not to be a function of the plant itself, but to be due to the action of atmospheric oxygen; and as the yellow or brown colour of most balsams darkens on exposure to the air, the blue colour may be one of the stable products of the oxidation.

Some botanists believe that this blue colour is the same as that produced in the well-known reaction of pine-wood with phenol and strong sulphuric acid. Tiemann and Haarmann showed that this was no doubt due to coniferin, since coniferin—when treated with sulphuric acid in varying proportion—strikes a violet colour changing to red, and when this solution is diluted with water a blue resin is deposited. Hartig found coniferin in *Larix Europæa*, and, according to Kupel, it exists in all "zapfenbaumen." Tiemann and Haarmann worked with the cambium layer of *Abies excelsa*, *A. pectinata*, *Pinus strobus*, *P. cembra*, as well as that of *Larix Europæa*. Lippman has also found it in beet-root and asparagus (*Ber.*, xviii., 3335); so that coniferin, as Singer has remarked, is far more general as a product of plant-life than is usually supposed.

The presence of coniferin in the two species of *Abies* above mentioned and the occurrence of the blue colour in *Abies balsamea* lead one to suppose that the conclusion that the blue colour is due to coniferin may be a correct one. Experiments were therefore tried on the blue colour from the birch tree, to determine whether it was identical with that found in the Canada balsam, or with that produced from coniferin, or with both.

The wood in which the blue colour was well developed was cut up fine and boiled with distilled water, giving a pale yellow solution, and then warmed with a mixture of alcohol and ether, which also yielded a solution of a pale yellow colour. The residue was finally extracted with chloroform, in which the blue colour is readily soluble, forming a fine blue solution. When the wood was treated with dilute potash a brown solution was obtained, which was turned blue by acids, and from which the colouring-matter could then be extracted with chloroform. Glacial acetic acid is also a good solvent for the pigment, and has the advantage of leaving undissolved the phlobaphene, the brown colouring-matter of the bark, which is abundant in the birch. This concentrated acetic acid solution is blue in colour, and is turned brown by potash, but the colour reappears on acidifying. When the chloroformic extract was evaporated, a blue non-crystalline mass was obtained, which was soluble in glacial acetic acid, but was turned brown on the addition of concentrated hydrochloric acid. The acetic acid solution, on warming or after standing for some time, loses its blue colour, so that after evaporating the greater part of the acetic acid a deep brown solution is obtained. This brown solution, on dilution with water, gave a brown precipitate, which was filtered off, washed, and dried. The solid was then insoluble in chloroform and carbon bisulphide, but was redissolved by glacial acetic acid, and apparently by potash and ammonia, yielding a yellow-brown solution. Nitrous acid, chlorine, and bromine gave no definite reaction with the body. The alkaline solution, on acidifying with hydrochloric or other mineral acid, gave a bright blue precipitate.

Reducing agents (*e.g.*, ammonium sulphide or stannous chloride) destroy the blue colour, but it can be reproduced by the cautious addition of nitric acid.

The chloroform solution was examined spectroscopically, and was found to give a faint, but definite, absorption-band in the yellow-red part of the spectrum, between the positions of the C and D lines. In this respect the blue colouring-matter of the birch differs from that obtained from the Canada balsam, since Girdwood and Bemrose obtained with it no special absorption-bands.

Through the kindness of Prof. Girdwood, who furnished me with a specimen of the Canadian colouring-matter, I have been enabled to compare its reactions with those above described, and from such examination it appeared evident that the colouring-matter of the birch did not present precisely the same characteristics as that derived from the Canada balsam.

To determine whether the blue colour was due to coniferin several specimens of birch-wood, in different stages of growth, were carefully tested for the presence of coniferin, but no trace of this glucoside could be found by the tests applied.

Some of the blue colouring-matter produced by the action of strong sulphuric acid upon coniferin, prepared from pine-wood, was prepared by precipitating the strongly acid solution with a large quantity of water. The blue colouring-matter is soluble in the stronger acids to a deep red solution; in weaker acids, such as acetic acid, to a blue solution; and the addition of potash or soda to these solutions gives a green colour. Stannous chloride in the cold has little reducing action on the acid solution. The solutions in acetic and sulphuric acids were examined by the spectroscope, and yielded absorption spectra which were different from that obtained from the blue colouring-matter of the woods examined. It was also completely insoluble in chloroform. It thus differs very considerably from the natural blue colouring-matters.

The amount of colouring-matter extracted from the wood was insufficient to allow of a complete analysis of it being made. It was, however, tested for nitrogen, and found to give with the sodium reaction only the merest trace of a cyanide, and when treated with soda-lime no ammonia was evolved. It seems therefore not to contain any nitrogen. When heated, it completely decomposed and left no ash, showing that the sample prepared contained no mineral matter.

From the above facts, then, it may be concluded that

the blue colouring-matter in decaying wood is not due to coniferin,—at any rate in some cases,—and that in all probability there are several different blue colouring-matters produced in this manner. These colouring-matters may be due to the action of organisms which flourish in an environment such as that presented by the damp and decaying underwood of dark forests, and so be classified with similar colours produced by chromogenous schizophytes in other kinds of organic matter undergoing decay.

ELECTROLYSIS OF MOLYBDENUM SOLUTIONS.

By EDGAR F. SMITH and W. S. HOSKINSON.

IN a paper published by one of us (S.) in the *American Chemical Journal*, vol. i., No. 5, attention was directed to the action of the electric current upon alkaline molybdic acid solutions. We there showed that although this method of precipitation was complete, yet the unusual time (100 hours) required rendered it practically useless. Since then we have found that by employing neutral solutions, or such as contain a very slight excess of sulphuric acid, quite satisfactory results can be obtained.

The form in which the molybdenum separates on the crucible sides is as black $Mo_2O_{33}H_2O$, as already observed (vol. i., No. 5). When the precipitation is complete the liquid is carefully syphoned off, the bright, compact coating washed with water, and the crucible with its deposit dried upon a water-bath (about 90°) and weighed. It may be well to carefully ignite the black oxide in a covered crucible and thus convert into trioxide, and weigh in the latter form.

In Volume 4 of the *Handwörterbuch der Chemie* it is stated that the electric current precipitates metallic molybdenum from solutions of ammonium molybdate. The determinations made by us under varying conditions do not confirm this statement. Our product in all instances was $Mo_2O_{33}H_2O$.

For our experiments we employed solutions containing different amounts of molybdenum. The precipitation was made in a platinum crucible of about 30 c.c. capacity, although the dilution rarely exceeded 25 c.c., so that space remained for exposure of fresh surface, and in this way afforded a ready means of knowing when the precipitation was complete. The filtrate and washings from the deposit were always examined for molybdenum. The deposition of oxide occurs upon the zinc pole of the battery.

Experiments.

I. In a solution containing 0·0093 grm. molybdenum as ammonium molybdate we obtained by electrolysis—

	$Mo_2O_3.3H_2O$.	Mo.
1.	0·0146 grm.	0.0095 grm.
2.	0·0146	0·0095
3.	0·0138	0·0090
4.	0.0137	0·0089
5.	0·0138	0·0090
6.	0·0142	0·0092
7.	0·0143	0·0093
8.	0·0146	0·0095
9.	0·0146	0·0095
10.	0·0146	0·0095

Molybdenum was not found in the filtrate. The time required for the above precipitations was two hours in each case. The current was obtained from four small-size Grove cells.

II. The solution contained 0·0156 grm. of molybdenum. We obtained—

	$Mo_2O_3.3H_2O$.	Mo.
11.	0·0236 grm.	0·0154 grm.
12.	0·0239	0·0156
13.	0·0245	0·0160
14.	0·0228	0·0148

The time of precipitation was two hours. Used four Grove cells. No indications of molybdenum in any of the solutions after the deposition of oxide.

III. A solution containing 0·0167 grm. molybdenum gave—

	$Mo_2O_4.3H_2O$.	Mo.
15.	0·0256 grm.	0·0167 grm.
16.	0·0252	0·0164
17.	0·0258	0·0168
18.	0·0258	0·0168
19.	0·0257	0·0166

Three hours were employed in precipitating the above quantities. Four Grove cells. Molybdenum not found on testing the filtrates.

IV. We found in a solution containing an unknown amonnt of molybdenum—

20.	0·0325 grm.
21.	0·0329
22.	0·0330
23.	0·0315

The time was three hours. Employed the same battery power as in the other determinations; 23 is the only instance where molybdenum was detected.

The action of the current upon molybdenum solutions containing other metals is receiving study at present.—*American Chemical Journal.*

Researches on Uranium.—(Third Treatise).—Clemens Zimmermann.—This memoir and the succeeding one have beeen edited by G. Alibegoff and G. Krüs from the posthumous papers of the late author. Concerning the intermediate oxides of uranium Zimmermann reached the following conclusions:—U_3O_8 is permanent only if heated in a current of oxygen and allowed to cool in it. If U_3O_8 is heated in air and cooled quickly it loses a small and variable quantity of oxygen, which is greatly increased if it is allowed to cool in an indifferent gas. If heated in an indifferent gas, such as nitrogen or carbon dioxide, U_3O_8 is gradually decomposed and completely converted into uranium dioxide. Peligot's black oxide is simply a mixture consisting chiefly of U_3O_8 with more or less UO_2, and has not a definite composition, such as, *e.g.*, U_2O_5. The colour of U_3O_8 is not a decisive mark of its purity, since, when purest, it has often a complete black aspect, whilst the streak, even of black U_3O_8, upon unglazed porcelain is always green. The difference of colour is therefore determined by the density of the preparation and the temperature to which it has been heated. The atomic weight of uranium Zimmermann determines as 239·02.—*Liebig's Annalen*, ccxxxii., Part 3.

Particulars on Commercial Orpiment and on the Unhairing of Hides.—M. Terreil.—This orpiment (*orpen*) is not the true orpiment,—a yellow arsenic trisulphide,—but it is red, and agrees approximately in composition with realgar, or arsenic disulphide. It contains, however, a little trisulphide. It is applied mixed with lime, either to the flesh side of the hide only, if it is intended to preserve the wool or hair, or the hides are entirely immersed in the same mixture. The arsenic sulphide dissolves in the hydrated lime, forming a soluble sulpho-salt which reacts upon the animal tissue, causing it to swell up so that the hairs easily become detached. Hides which have been steeped in water previous to unhairing present afterwards black spots in parts which while still moist have been in contact with articles of rusty iron, or upon which particles of iron have become fixed. There are then formed ferruginous spots, which the sulpho-salt afterwards converts into black iron sulphide. Such spots are most frequent when the skins, before being handed over to the tanner, have been dried in presence of preservative agents, so-called, which contain iron. The black spots consist simply of iron sulphide free from foreign matters.—*Bull. de la Soc. Chim. de Paris.*

HYDRATION OF SALTS.

By Miss E. M. FARRER and S. U. PICKERING.

It is generally assumed that the water of crystallisation contained in a salt is given off at 100°, and as a rider to this assumption we find that whatever water is not evolved till higher temperatures be reached is considered to be not water of crystallisation, but water of constitution, whatever that may mean. This theory finds a ready acceptance in cases where it is possible, however illogically, to represent this water as part of the salt itself, as in the case of the sulphates; but the fact that in many, and perhaps most, other cases, where the formulæ of the salts do not admit of such a view, some water is retained at high temperatures in a precisely similar manner is generally overlooked.

In attempting to prepare specimens of several anhydrous salts this fact has of late been forced on our consideration.

Manganese chloride was one of the salts taken. The crystallised salt, on analysis, was found to contain the theoretical percentage of water corresponding to the formula $MnCl_2,4H_2O$. On being heated in dry air at 100° it lost an amount of water represented as nearly as possible by $3H_2O$ (found 27·05 per cent, calculated 27·30 per cent): a slightly higher temperature, however, sufficed to bring about a further loss, which proceeded at a very slow rate. At 200° to 230° the salt again became constant in weight, having experienced a loss of 37 per cent in one case and 35·9 in another, agreeing moderately well with the theoretical loss for $4H_2O$ of 36·4 per cent. The preparations, however, were found to be by no means anhydrous, even after many hours heating at this high temperature; they still retained about 2·5 per cent of water, the loss in weight which had been experienced having been augmented by the loss of some chlorine in the form of hydrochloric acid, and the consequent formation of some manganous oxide. This oxidation was found to have taken place to an appreciable, though much smaller extent when the salt had been heated to 100° only.

Similar attempts to prepare an undecomposed specimen of the anhydrous salts, by treating the double salt which it forms with ammonium chloride, were unsuccessful. By crystallising solutions of the two chlorides a salt was obtained corresponding to the formula $MnCl_2,4NH_4Cl,3H_2O$, which has not been before described.* It gave on analysis—

	Found.		Calculated.
Cl	54·372		54·159
NH_3	17·635 17·011 17·386	17·344	17·351

This salt, on being heated in dry air, gave off water and ammonium chloride at 100°; but even at 220°, after prolonged heating, it still retained a considerable amount of water, although the ammonium chloride had all been expelled, and about 4 per cent of the salt had been oxidised. The amount of oxide formed in this case was considerably greater than in the previous experiments with the manganese chloride itself, but it no doubt depends on the manner in which the heating is conducted and the rate at which the water is expelled: when samples of the single and the double salt were heated side by side in the air-bath, for two hours at 200°, the former underwent five times as much oxidation as the latter.

The behaviour of the chloride of manganese would appear to be typical of that of the chlorides of most of the dyad metals: with those of iron and magnesium, indeed, the salt is decomposed much more readily than in the case of manganese, and long before it approaches an anhydrous condition: even in a case such as that of strontium chloride, where no appreciable decomposition occurs, 1 per cent or more water is retained at 250°, and cannot be expelled below a red heat. Nor are the chlorides the only salts which retain small quantities of water at temperatures above 200°; the authors have found the same behaviour to be exhibited by sodium pyrophosphate, sodium ferrocyanide, potassium ferrocyanide, and strontium nitrate, and there can be little doubt but that, if the loose and antiquated statements on which our knowledge of the properties of most salts rests were examined with a little care, it would be found that it is only in exceptional cases that a crystallised salt may be completely dehydrated at 100°; at present, at any rate, we may safely conclude that neither 100° nor any other temperature can be taken as that at which water, which must necessarily be considered as water of crystallisation, is given up by a hydrated salt.

The decomposition of the chlorides while being dehydrated is a point of some theoretical interest. It is not due to the oxidising action of the air at the high temperature employed, for both the manganese chloride and the manganese ammonium chloride were found to be oxidised in the same manner when the dehydration was conducted in an atmosphere of hydrogen; nor can it be regarded as due to a limited double decomposition between the salt and the water liberated, for in such cases (that of the magnesium chloride being the most notable and best known one) the salt is stable in the presence of even a large amount of water at 100°, and its solution may be boiled for any length of time without suffering decomposition;* it is only when the component parts of the compound molecule are being split asunder,—

$$[(M''Cl_2)(\alpha H_2O)]$$

that this decomposition occurs. Two explanations of this fact may be offered: first, that such compound molecules are not in reality so simple in construction as they are represented; that the water present, though still water of crystallisation, is united to the chloride, not as molecule to molecule, but through the valencies of the compound atoms in these molecules, so that the water cannot be removed without affecting the atoms composing both itself and also the $M''Cl_2$,—a view which one of us has elsewhere given in detail: or, secondly, that the molecule of the hydrated salt, not being in reality $M''Cl_2\alpha H_2O$, but $x(M''Cl_2\alpha H_2O)$, when decomposed so as ultimately to form molecules which may be represented as $y(M''Cl_2)$ and $z(H_2O)$, gives rise to the transitory existence of the isolated—or, as we may perhaps call them, nascent—molecules, $M''Cl_2$ and H_2O, which, being very different from the complex arrangement which actually constitute the units of any substance in a stable condition, react with each other in a manner in which the more stable molecular aggregates are incapable of doing.

* The manganese ammonium chlorides already known are—
$MnCl_2,2NH_4Cl$, H_2O (Rammelsberg, Pickering);
$MnCl_2,2NH_4Cl,2H_2O$ (v. Hauer);
$MnCl_2$, $NH_4Cl,2H_2O$ (Hautz).

* The anhydrous chlorides, in those cases where they have been obtained by indirect means, have also been found to be perfectly stable at these temperatures.

ON THE

WIDESPREAD OCCURRENCE OF ALLANITE AS AN ACCESSORY CONSTITUENT OF MANY ROCKS.

By JOSEPH P. IDDINGS and WHITMAN CROSS,
Of the U.S. Geological Survey.

More than a year ago, while engaged in the microscopical study of rocks from widely separated regions, the writers observed in the thin sections occasional crystals or grains of a highly refracting brown mineral, which was not referable to any of the more common rock-building species. The study of a number of sections showed that the crystals were monoclinic and apparently isomorphous

with epidote, that is, elongated in the direction of the ortho-axis with the base and orthopinacoid well developed, two positive orthodomes less prominently, and with terminal planes belonging apparently to the unit prism. In a few instances imperfect cleavage was noticed parallel to *i-i* and *O*, and in one case to *i-ī*. A twining parallel to *i-i*, as in epidote, was frequently observed.

The optical axes were found to lie in the plane of symmetry, one of the bisectrices making an angle of 35° to 40° with the vertical axis and 25° to 30° with the clino-axis. A strong pleochroism, from light yellowish brown to dark chestnut brown, was always noted, as also a high index of refraction. These characters strongly indicated the identity of this mineral with allanite, and a qualitative chemical analysis, made by Dr. W. F. Hillebrand in the Denver laboratory of the U.S. Geological Survey, fully confirmed the correctness of the microscopical determination. The material analysed was derived from a biotite porphyrite of the Ten Mile District, Colorado, in which the mineral occurred in exceptional abundance. The process of separation and analysis is described by Dr. Hillebrand as follows: "The mineral supposed to be allanite was separated from the rock, together with much magnetite and some zircon, by means of the Sonstadt solution. The magnetite being removed by a magnet, the other minerals were left quite free from further admixture. They formed approximately 0·05 per cent. of the whole rock.

"In order to preserve the zircon crystals intact, the mixture was treated, without pulverisation, for many days in a platinum crucible with hydrochloric acid. The residue was zircon and silica retaining the original form of the allanite fragments. This silica after filtration was entirely soluble in hot sodium carbonate. After separating silica in the hydrochloric acid solution, the latter was boiled with potassium hydrate. The filtrate then showed much alumina and lime, and very little magnesia. The precipitate by potassium hydrate was dissolved in hydrochloric acid, diluted, and to it a concentrated solution of oxalic acid added. The precipitate, at first curdy, was ignited, dissolved in sulphuric acid, evaporated, and ignited gently, the sulphates dissolved in cold water, and crystals of potassium sulphate added. After washing the insoluble double sulphate formed with a potassium sulphate solution, ammonia formed no precipitate in the filtrate, showing the absence of erbium and yttrium. The double sulphates dissolved very readily in water acidulated with hydrochloric acid, and were then decomposed by oxalic acid; the ignited precipitate was brown, readily soluble in hydrochloric acid with evolution of chlorine, indicating thereby the presence of both cerium and lanthanum, and absence of thorium. No didymium absorption lines were visible in the spectroscope. The oxalates, when dissolved in strong nitric acid and boiled with lead dioxide, gave a yellow solution showing the presence of cerium. Further tests were rendered impossible by the loss of the material.

"Although in the beginning only a qualitative analysis was contemplated, owing to the small amount of material, nevertheless the silica, alumina, ferric oxide, mixed cerium and lanthanum oxides, and the lime were weighed, and found to bear to one another the average ratio of those constituents in allanite."

Considering the identity of the mineral as established, the following additional particulars as to its characteristics and distribution may be of interest.

Crystals which are large enough to be seen without the aid of a lens are easily recognised in the hand specimen by their brilliant black colour, uneven fracture, and oily lustre. They vary greatly in form and size in the different rocks examined, in some cases being long slender prisms, reaching a maximum length of 1 c.m., though usually appearing in short, stout prisms, or in quite irregular grains of microscopic dimensions. In thin sections from a great number of localities the colour is uniformly a rich chestnut-brown with the strong pleochroism already mentioned, but in a few instances a zonal variation has been noticed, the colour growing lighter from the centre of the crystal outward. Cleavage is in most cases wholly absent.

A confusion with hornblende or biotite is only possible when these minerals are of nearly the same shade of brown, and are so cut by the section as to show no distinct cleavage. But the lack of pleochroism and the nearly uniaxial character of a basal section of biotite—the only one not exhibiting cleavage—sufficiently distinguishes it from the strongly pleochroic, biaxial allanite. In the exceedingly rare cases where hornblende possesses the peculiar chestnut-brown color, and shows neither characteristic cleavage nor outline, one can only distinguish the allanite by its higher index of refraction, which produces more brilliant interference colours between crossed nicols.

From its mode of occurrence and association allanite must be added to the group of primary, accessory rock constituents, similar to zircon, sphene, and apatite, though much rarer than any of these. In one instance it was noticed enclosing zircon, in others, sphene, apatite, and magnetite, but it has also been found in such connection with these minerals as to indicate a contemporaneous growth. Its nature as a primary constituent in eruptive rocks is further attested by its occasional inclusion in biotite, felspar, and quartz.

In some regions it appears to be quite uniformly distributed through certain types of rock. Thus, in the porphyrites and allied porphyries of the Ten Mile district, Colorado, prismatic crystals of allanite may be seen in numbers upon nearly every hand specimen—one exhibiting as many as forty on its surface—and few thin sections of these rocks were examined without one or more being discovered. On the other hand, in the vicinity of Eureka, Nevada, it seems to be very irregularly disseminated through a considerable range of rock types, two or three microscopical individuals being recognised in quite a number of thin sections—and in one instance as many as eleven—but in the majority of sections it is absent altogether. In most of the rocks studied the mineral occurs very sparingly.

In almost every instance the allanite is perfectly fresh and unaltered. Macroscopic crystals are occasionally seen to be reddish brown in colour, with a more or less deeply stained zone surrounding them. In one partially decomposed rock, a transition of allanite to epidote is indidicated by crystals of the former enclosing scattered grains of epidote in such a manner as to leave little doubt that they result from an alteration of the enclosing mineral.

It is interesting finally to notice how extensively allanite is disseminated in minute quantities through rocks of a great variety of types and from widely separated localities. Without undertaking any special investigation of the matter we have found it microscopically in metamorphic rocks, in older crystalline eruptive masses, and in glassy lavas; in hornblende gneiss and mica gneiss, in granite, granite porphyry, quartz porphyry, diorite, porphyrite, andesite (glassy), dacite, and rhyolite; and from localities in the States of Maine, Massachusetts, Rhode Island, Colorado, and Nevada, and the Territories of Wyoming and Utah. Below is appended a list of the rocks and localities alluded to, which will no doubt be greatly enlarged by other observers.

Gneiss.—Utah: Ogden Cañon; Farmington Cañon, Wahsatch.
Wyoming: Medicine Bow Range.
Nevada: Clover Cañon, E. Humboldt Mountains.

Granite.—Maine: Vinalhaven, Biddeford, Wayne, Fox Island, Harrington.
Massachusetts: Lynnfield.
Rhode Island: Westerly.
Utah: Little Cottonwood Cañon.
Nevada: Eureka.

Granite Porphyry.—Utah: Tooele.
Nevada: Eureka.
Quartz Porphyry.—Colorado: Mosquito Range, Park County; Eagle River, Eagle County.
Diorite.—Nevada: Truckee Cañon.
Porphyrite.—Colorado: Mount Silverheels, Park County; Mosquito gulch, Park County; Ten Mile District, Summit County.
Utah: Henry Mountains.
Andesite (glassy).—Nevada: Eureka.
Dacite.—Nevada: Eureka, Shoshone Park; Washoe.
Utah: White Rock Mountain.
Rhyolite.—Nevada: Eureka.

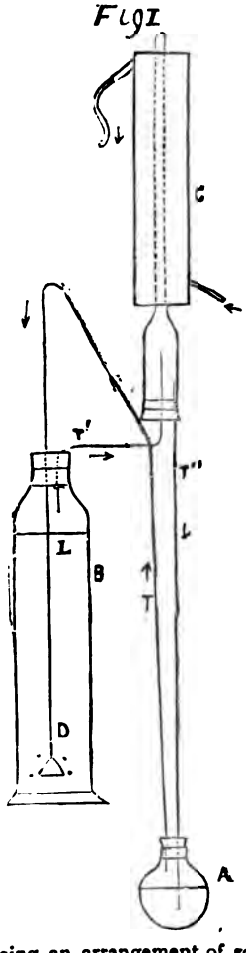
—*American Journal of Science.*

APPARATUS FOR THE EXTRACTION OF DISSOLVED SUBSTANCES FROM LIQUIDS WITH LIGHT VOLATILE SOLVENTS.

By ARNOLD EILOART, B.Sc.

APPARATUS for this purpose have been recently described by Neumann (*Ber. d. Deutsch. Gesell.*, xviii., 3061). In this case a syphon was used to remove the solvent after it had passed through the liquid to be extracted, and I had

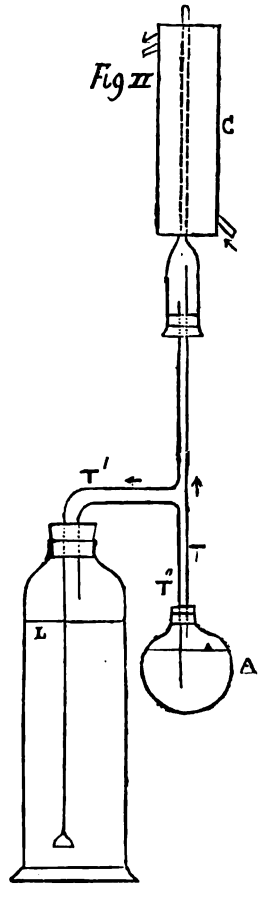
Fig I



myself been using an arrangement of somewhat similar principle. But in the course of work the following simple method was found preferable.

The solvent in the flask A (fig. 1) is heated by means of a water-bath, so that the vapour passes through the tube T to the bottom of the liquid to be treated with it (L), which is placed in the vessel B. As B is tightly corked, the condensed solvent, collecting above L, is next forced up the tube T' (which opens above the surface of L) and into the open condenser, C, from the bottom of which it is carried off by the tube T'' to return to A. The extra height of T above B checks regurgitation when A cools. It is evident that external heat may be applied to B to aid the extraction. If, on the other hand, it is necessary to avoid heating L by the condensation of the solvent, the arrangement shown in fig. 2 is adopted. Here the vapour passes first to the

Fig II



condenser, C, by the tube T, and the condensed solvent collects in T', which is of such a height that, by the weight of the column of liquid in that tube, a stream is forced through L and up T'', thus effecting the return to A. Some arrangement for spreading the solvent on its entrance to L will be found useful. For this a funnel (D) was fused to the tube T (fig. 1), and over its mouth platinum pierced with pin-holes was folded.

King's College Laboratory,
June, 1886.

Spontaneous Polymerisation of Volatile Hydrocarbons at Ordinary Temperatures.—Sir H. E. Roscoe, F.R.S.—The most volatile fractions of the hydrocarbons obtained on distilling crude phenol at a red heat are converted spontaneously into a crystalline hydrocarbon of the formula $C_{10}H_{12}$.—*Liebig's Annalen.*

ON ALLANITE AND GADOLINITE.*

By L. G. EAKINS.

The three minerals about to be described were analysed during the spring of 1885, and are part of a number collected by Mr. W. B. Smith, of the U.S. Geological Survey, and turned over by him to the laboratory of the survey for investigation, the remaining ones now being in the hands of Mr. W. F. Hillebrand. They are all from the same locality, namely "Devil's Head" Mountain, Douglas County, Col., the region being already described by Mr. Smith in the *Bulletin of the U.S. Geological Survey*, No. 20.

For the microscopical notes in connection with the following descriptions, I am indebted to Mr. Whitman Cross.

Allanite.

Allanite occurs scattered throughout a more or less decomposed granite, from which it was separated for analysis by the Thoulet solution.

Colour:—Pitch-black.

Lustre:—Brilliant, glossy.

Fracture:—Sub-conchoidal.

Microscopical:—Interior pale greenish yellow, with irregular fissures. Isotropic, often there is a zone about the kernel, which is chestnut to strong yellowish brown, pleochroic, and strongly doubly refractive.

This outer zone is identical in behaviour with the allanite of eruptive rocks. From the presence of apparent rude prismatic forms one would infer that the amorphous state is in this case a secondary one.

Heated before the blowpipe a fragment swells to several times its original size. It is readily decomposed by acids.

Sp. gr. 3·52 at 29° C.

H. about 6.

The analysis is as follows:—

SiO_2	31·13
Al_2O_3	11·44
Fe_2O_3	6·24
Ce_2O_3	12·50
$(LaDi)_2O_3$	10·98
FeO	13·59
BeO	0·27
MnO	0·61
CaO	9·44
MgO	0·16
K_2O	trace
Na_2O	0·56
H_2O	2·78
CO_2	0·21
P_2O_5	trace
	99·91

Gadolinite.

Of this mineral there were two specimens, of which separate analyses were made; they are figured in the Table below as I. and II.

The description of the material which furnished Analysis I. is as follows:—

The specimen resembled, externally, a stone worn and rounded by the action of water: when broken, a black, slightly lustrous surface was exposed.

Fracture:—Smooth.

Cleavage:—Apparently none.

Microscopical:—Dark green. Isotropic.

The section was fissured, with films and flakes of dark reddish brown oxides in them.

Before the blowpipe it glows brilliantly.

Sp. gr. 4·56 at 17° C.

H. 6—6 5.

The material which furnished Analysis II. differs very much in appearance from the one just described.

* *Proceedings of Colorado Scientific Society*, vol. ii., 1885.

It also was in fragments, but none of them displayed the worn, rounded appearance of the other.

In colour it was less dark, approaching at places to a dull green.

Sp. gr. 4·59 at 25·5° C.

H. about 6.

As these two analyses are the first of material from this country it has been considered advisable to add the analyses of gadolinite from two of the noted European localities. They are given in the Table as III. and IV., III. being from Ytterby and IV. from Hitteroe. They are taken from an article by Humpidge and Burney in the *Zeitschrift fur Krystallographie*, vi., p. 94.

	Eakins.		Humpidge and Burney.	
	I.	II.	III.	IV.
SiO_2	22·13 (*b*)	21·86	25·16	24·24
Al_2O_3	2·34	0·54	—	—
Fe_2O_3	1·13	3·59	2·15	—
ThO_2	0·89 (*c*)	0·81	—	—
Ce_2O_3	11·10 (*c*)	6·87	Ce, La, Di O_3 6·52	9·93
$(LaDi)_2O_3$ ..	21·23	19·10 (*e*)		
Er_2O_3	12·74 (*d*)	15·80 (*f*)	4·11	10·91
Y_2O_3	9·50 (*d*)	12·63 (*f*)	35·16	30·59
FeO	10·43	11·36	12·40	16·04
BeO (*a*)	7·19	5·46	9·39	6·56
MnO	—	0·11	—	—
CaO	0·34	0·47	1·11	0·79
MgO	0·14	0·16	trace	0·24
K_2O	0·18	0·20	—	trace
Na_2O	0·28	0·32	—	—
H_2O	0·86	0·74	2·32	0·62
P_2O_5	—	—	1·28	—
Total ..	100·48	100·02	99·60	99·92

(*a*) Humpidge and Burney use Be_2O_3 instead of BeO.

(*b*) Mean of 22·10 and 22·15.

(*c*) A second determination gave for $ThO_2 + Ce_2O_3$ = 11·82.

(*d*) The molecular weight of the mixed oxides Er_2O_3 and Y_2O_3 = 296.

(*e*) Didymium absorption line very strong.

(*f*) The molecular weight of the mixed oxides Er_2O_3 and Y_2O_3 = 294.

In Analysis I. and II. the Er_2O_3 and Y_2O_3 were calculated by the formula of Bahr and Bunsen, after the conversion of the oxides into sulphates.

Er_2O_3 = 4·79 wt. oxides — 2·33 wt. sulphates.

The absorption spectrum of erbium from one grm. of the mineral in a solution 2 c.m. thick and 1 c.m. deep was so weak that only the band in the green was visible, being but little darker than the two dark Fraunhofer lines on each side.

In the notes in connection with the analyses given here as III. and IV., Humpidge and Burney make the following remarks:—

"The P_2O_5 (for the first time discovered in gadolinite), is combined with cerium metals, for it remains undissolved on treatment with aqua regia. Xenotime could not be detected in thin sections, the whole appearing as a homogeneous, isotropic, green mass. The above analyses contradict the statement of Descloiseaux that the amorphous gadolinites are free from Be_3O_3."

It will be noticed in regard to this last statement that my analyses lead to the same conclusion.

On Lanoline.—M. Boymund.—Lanoline, a fat derived from the suint of wool, is a perfectly neutral body, and does not lose its neutrality under the influence of water. It is easily miscible with fatty bodies, and dissolves in ether, chloroform, benzol, and carbon disulphide, but it is insoluble in alcohol even with the aid of heat. The author has studied its properties from a pharmaceutical point of view.—*Journ. de Pharm.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 3rd, 1886.

Dr. HUGO MÜLLER, F.R.S., President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Bennett F. Davenport, M.A., M.D., 751, Tremont Street, Boston, Mass.; W. Ralph Dodd, 55, Listria Park, Stoke Newington; Albert Brown Lyons, M.A., M.D., Detroit, Michigan, U.S.A.; James B. Readman, F.R.S.E., 9, Moray Place, Edinburgh; Edgar F. Smith, Ph.D., Wittenberg College, Springfield, Ohio.

The following papers were read:—

55. "*Notes on Sir W. Fairbairn's Experiments on Re-melting Cast Iron.*" By THOMAS TURNER, Assoc. R.S.M.

In 1853 Sir W. Fairbairn re-melted Eglinton hot-blast pig iron 18 times in order to ascertain the effect produced by repeated melting (*B. A. Report*, 1853, 87). The metal at first gradually improved, but afterwards rapidly deteriorated, becoming white and hard. The following analyses of the bars are due to Crace Calvert.—

1st melting	..	Si = 0·77		S = 0·42		C = 2·76
8th	„	..	„	1·75	„	0·60	„ 2·30
10th	„	..	„	1·98	„	0·26	„ 3·50
18th	„	..	„	2·22	„	0·75	„ 3·75

The author recently attempted, with the aid of these results, to explain the effect observed. The accuracy of these analyses had been questioned by Snelus and others, and by the kindness of Professor Unwin the author has been enabled to repeat the chemical examination. His results have been confirmed by separate analyses performed by Mr. J. P. Walton. The mean of their experiments give the following results:—

No. of melting.	Total carbon.	Combined.	Silicon.	Sulphur.	Manganese.	Phosphorus.
1	2·67	0·25	4·22	0·03	1·75	0·47
8	2·97	0·08	3·21	0·05	0·58	0·53
12	2·94	0·85	2·52	0·11	0·33	0·55
14	2·98	1·31	2·18	0·13	0·23	0·56
15	2·87	1·75	1·95	0·16	0·17	0·58
16	2·88	—	1·88	0·20	0·12	0·61

It follows, therefore, that the author's previous conclusions, based upon Calvert's analyses, were erroneous, and that the action of re-melting was one of oxidation, resembling in character that of the "refinery," the puddling furnace, the open-hearth furnace, or the Bessemer converter.

56. "*Some Ammonium Compounds and other Derivatives of α-1′ Hydroxyquinoline.*" By C. A. KOHN, B.Sc., Ph.D.

The author first describes the methiodide of hydroxyhydromethylquinoline and its conversion on being heated with solid caustic potash into methoxyhydromethylquinoline: he regards this isomeric change as being due to the formation, in the first place, of potassoxyhydromethylquinoline methiodide, from which potassium iodide is then split off, the added methyl group taking the place of the displaced potassium. Methoxyhydromethylquinoline methiodide is converted by moist oxide of silver into the corresponding hydroxide, which on heating is decomposed into methyl alcohol and methoxyhydromethylquinoline. The corresponding hydroxyhydroethylquinoline compounds are described. Hydroxyhydroethylquinoline ethiodide yields with caustic potash O. Fischer's ethylkairin; the corresponding hydroxide appears to be decomposed on heating into ethylkairin, ethylene, and water. An attempt to prepare a benzyl chloride addition-product of hydroxyhydromethylquinoline was not attended with a satisfactory result: on heating the product with caustic potash what appeared to be a benzylhydromethylquinoline was, however, obtained, and hence it is most probably the added radicle that is displaced.

Acetoxyhydroethylquinoline was also prepared. It possesses only feeble basic properties, and is readily decomposed. By the action of ethylene bromide on hydroxyhydroquinoline a hydroxyhydroethylenequinoline was obtained. Several salts and characteristic reactions of this derivative are described: it is a weak base as well as a weak acid. An investigation of its physiological properties by Professor Filehne shows that it acts like kairin in reducing temperature, but that its action is a far feebler one—a fact due in all probability to its weaker basic properties. The effect of nitrating ethoxyhydroethylquinoline is also mentioned: two nitro-groups are at once introduced, as is the case with hydroxyquinoline.

57. "*β-Sulphophthalic Acid.*" By Prof. C. GRAEBE and A. RÉE, Ph.D.

The preparation and properties of this acid, in which COOH : COOH : SO_3H = 1 : 2 : 4, and of its salts, are fully described: it may be obtained either by oxidising commercial naphthol yellow S.—dipotassium dinitro-alphanaphtholsulphonate—with nitric acid, or by the action of sulphur trioxide on phthalic anhydride, a relatively small amount of the isomeric 1 : 2 : 3 sulphuric acid being also formed in the latter case. The purification of the acid is best effected by means of the monobarium salt, $[C_6H_3(CO_2H)_2.SO_3]_2Ba.5OH_2$, one of the most characteristic of its salts. On evaporating an aqueous solution in the water-bath to a syrup, and completing the removal of water by heating in the air-bath below 100°, β-sulphophthalic acid is obtained as a crystalline monohydrate; on heating this at 140° the acid is obtained as a thick syrup, which may be converted by prolonged heating at 180° into a crystalline mass of anhydrosulphonic acid, $C_6H_3(C_2O_3).SO_3H$. On treatment with PCl_5, sulphophthalic acid yields two acid chlorides—a crystalline monochloride, $C_6H_3(COOH)_2.SO_2Cl$, from which the corresponding sulphonamide may be obtained by the action of ammonia, and a non-crystalline trichloride, $C_6H_3(C_2O_2Cl_2).SO_2Cl$, which decomposes on distillation into SO_2 and β-chlorophthalic chloride.

58. "*Compounds obtained by the aid of β-Sulphophthalic Acid.*" By the same.

β-Hydroxyphthalic acid was obtained by fusing sodium β-sulphophthalate with 2½ times its weight of sodium hydroxide at a temperature not exceeding 180°; if this temperature be much exceeded, methydroxybenzoic acid is produced, this acid being also formed in theoretical quantity on heating β-hydroxyphthalic acid with dilute muriatic acid at 180°.

β-Hydroxyphthalimide was prepared by acting with ammonia on β-hydroxyphthalic anhydride; it is converted into *β-hydroxyphthalide* by digestion with tin and muriatic acid, and treatment of the nitroso-derivative of the β-hydroxyphthalidine thus formed with caustic soda.

By heating the monochloride of β-sulphophthalic acid with phosphorus pentachloride at 220°, a quantitative yield of *β chlorophthalic chloride*, and consequently of β-chlorophthalic acid, may be obtained. The chloride boils at 275°; *β-chlorophthalic anhydride* melts at 99° and boils at 296° (corr.). The same methylic salt is obtained by the action of methylic alcohol on β-chlorophthalic chloride and anhydride, and by the action of methyl iodide on silver β-chlorophthalate: this result is of interest, as on the assumption that phthalic chloride is of unsymmetrical constitution ethereal salts prepared from a phthalic chloride should differ from those obtained either from the anhydride or the silver salt, and this has been proved to be true in the case of tetrachlorophthalic acid.

β-Chlorophthalimide, obtained by the action of ammonia on the anhydride, melts at 210—211°. *β-Chlorofluorescein* closely resembles fluoresceïn.

By the action of aluminium chloride on a benzene solution of β-chlorophthalic anhydride, *metachlorobensoyl-*

benzoic acid is formed, from which *metachloranthraquinone* is readily obtained by condensation with sulphonic acid.

On fusion with sodic formate, β-sulphophthalic acid yields trimellitic (1 : 2 : 4 benzenetricarboxylic) acid.

59. "*Derivatives of Taurine.*" Part II. By J. William James.

An account is given of experiments to determine the constitution of the trimethyltaurine previously described by the author (*Trans.*, 1885, 367). Boiling iodhydric acid has no action on it: therefore, as all compounds containing methoxyl yield methyliodide when thus heated, the formula $NMe_2 \cdot C_2H_4 \cdot SO_2OMe$ is excluded. Trimethyltaurine is readily decomposed by boiling with alkalies, trimethylamine and isethionate being formed; cyanamide does not combine with it: hence it must be supposed that it differs in constitution both from taurine and the mono- and dialkyl-taurines—which are not decomposed by alkalies, but all form crystalline compounds with cyanamide. The author therefore represents the trialkyltaurines alone as analogues of betaine, thus:—

$C_2H_4\begin{cases}NH_2\\SO_2\cdot OH\end{cases}$ Taurine. $C_2H_4\begin{cases}NHR'\\SO_2\cdot OH\end{cases}$ Monalkyltaurine. $C_2H_4\begin{cases}NR_2'\\SO_2\cdot OH\end{cases}$ Dialkyltaurine.

$C_2H_4\begin{cases}NR_3'\\ \diagdown\\SO_2\cdot O\end{cases}$ Trialkyltaurine.

Finally, a description is given of an *imide* of the formula

$$C_2H_4\begin{cases}NH\\SO_2\end{cases},$$

obtained by the action of dry ammonia-gas on an ethereal solution of β-chlorethanesulphonic chloride,—

$$Cl\cdot C_2H_4\cdot SO_2Cl;$$

it is an extremely stable body, not being decomposed by boiling with alkalies; the imidic hydrogen can be displaced by metals.

Discussion.

Dr. Armstrong expressed the opinion that the properties of taurine and its derivatives were such that it was impossible to represent them as sulphonic *acids*; he thought that they were all equally to be regarded as ammonium compounds of the glycine and betaine type, and, judging from their physical properties, that neutralisation was probably brought about by the union of 2 mols. of the parent amido-sulphonic acid. The evidence brought forward was scarcely sufficient to warrant the assumption that trimethyltaurine was esentially different in constitution from taurine and the mono- and di-alkyl-taurines.

Dr. Sprengel desires it to be mentioned that at the meeting on May 20th he also exhibited three photographs taken at the moment of the explosion at Hell Gate, October 10th, 1885, when the mine was charged with 22 tons dynamite and 107 tons of a mixture of 21 parts nitrobenzene and 79 parts potassium chlorate. This mixture belongs to the safety explosives described by Dr. Sprengel in the *Chem. Soc. Journ.*, 1873, and according to General Abbot, U.S. Army, has the power 109, dynamite with 75 per cent nitroglycerine being 100.

At the next meeting, on June 17th, there will be a ballot for the election of Fellows, and the following papers will be read:—

1. "The Electrolysis of Aqueous Solutions of Sulphuric Acid." By Prof. H. McLeod, F.R.S.
2. "Essential Oils (Part III.), their Refractive and Dispersive Power." By Dr. J. H. Gladstone, F.R.S.
3. "The Formation and Destruction of Nitrates and Nitrites in Artificial Solutions and in River and Well Waters." By J. M. H. Munro, D.Sc.
4. "An Apparatus for Distillation under Reduced Pressure." By Dr. W. H. Perkin, F.R.S.
5. "The Electromotive Force produced by the Combination of Cadmium and Iodine in Presence of Water." By A. P. Laurie.
6. "A Method of Investigating the Constitution of Azo-, Diazo-, and Analogous Compounds." By R. Meldola, F.R.S., and F. W. Streatfeild.

TOKYO CHEMICAL SOCIETY.

The eighth annual meeting of this Society was held on April 10th, at the Botanical Garden of the Imperial University, Tokyo, Japan.

About thirty-five members of the Society met together, and amongst the guests present there were Drs. Divers, F.R.S., Wagener, Kellner, and Fesca; Mr. Watanabe, the President of the Imperial University; Mr. Orita, the head of the Educational Bureau; Professors Kichuchi, Yatabe, Ozawa, Shida, and Yamakawa.

The chair was taken at 4 p.m. by Prof. J. Sakurai, the President of the Society, who reported on the condition of the Society for the year ending March, 1886. The following is a brief abstract of the Report:—

"The increase in the number of members during the year is 12, and the total number of members at present is 86, of whom 59 are in Tokyo, 21 in provinces, and 6 abroad.

"Ten ordinary meetings and one annual meeting were held during the year, at the latter of which Dr. Divers delivered an important lecture on the 'Constitution of some Non-saturated Oxygenous Salts,' a paper which cost him a long and laborious experimental work, and which, in spite of the serious accident he had then only lately had, he read with unusual force and clearness.

"The number of papers contributed and read by the members at ordinary meetings amounts to 19, which are either of theoretical interest or of practical importance. Especially important, however, of these are the papers contributed by Mr. T. Shimizu,—the joint work of Dr. Divers and himself,—and a paper on the 'Chemical Examination of the Constituents of Camphor Oil,' by Mr. H. Yoshida.

"The *Journal* of the Society is published four times a year, viz., in March, June, September, and December, and it is hoped to make it in future a monthly journal, especially as the number of papers annually read is not very few, nor their nature inferior to those which appear in foreign journals.

"The Society has undertaken to translate chemical terms into Japanese, and it now possesses a Dictionary of commoner chemical terms in Japanese, English, French, and German.

"It has also undertaken to establish a system of chemical nomenclature in Japanese language, of which the nomenclature of elements and of inorganic compounds is already nearly finished. It is hoped that a sound and complete system of nomenclature will be published during the ensuing year.

"The donations to the Society are of various kinds and from various sources. They consist of journals of scientific societies, including Russian Chemical Society, 80 copies; pamphlets, 11 copies; books, 3 copies; reports and tables, 8 copies."

Mr. Watanabe, the President of the Imperial University, and Dr. O. Kellner having promised to address the Society, the Chairman then called upon the former gentleman to deliver his discourse.

The object of Mr. Watanabe's speech was to impress upon the minds of the members the necessity of making chemistry popular. He said that chemistry and physics, among other branches of Science, are the two which are most intimately connected with arts and manufactures, and that it is therefore highly necessary for chemists to show to the public that much improvement in our modern industry may be made by proper application of chemical

and physical sciences, and thus much time, labour, and money saved. Any science, he would say, which did not contribute to the improvement of the material world would, in the end, perish; and any scientific society which, however high its aim may be, did not encourage the applied aspect of the science would also, in the end, perish. He would therefore venture to suggest that the members of this Society should try their utmost to show to men of business that material benefits may accrue from their science. He, however, by no means imagines that original investigation is useless; on the contrary, he would strongly encourage it, and hopes that more original work may be done in our country.

Dr. KELLNER's paper was entitled "*On the Application of Human Excreta as Manure: the Deportment of Urea toward Soils.*" This is the result of an experimental investigation carried out at Komaba Agricultural College by Dr. Kellner, Professor of Agricultural Chemistry, with assistance of his pupils; and the following is its brief abstract:—

"It is a general custom, both in Japan and China, to use human excreta as manure, only in a *highly decomposed state.* The application of fresh excreta is regarded as objectionable, it being said that the plants supplied with them are liable to wilt.

"Having been consulted about this injurious influence, and nothing being known in regard to it, I resorted to a few experimental researches in order to find out its cause.

"Fresh excreta differ from decomposed ones in a two-fold way: on the one hand, the reaction of the former is acid, that of the latter alkaline; and on the other, but connected with the difference of reaction, the fresh urine is rich in urea, while the decomposed one is almost destitute of it, *the urea being converted during putrefaction into ammonium carbonate.*

"All considerations lead to the conclusion that the difference of reaction cannot explain the injuries done by fresh excreta, the acid as well as the alkaline reactions being soon neutralised by common soils. But the urea of fresh urine might in some way interfere with the normal process of vegetable growth.

"Owing to the weak affinities of urea, it was hardly to be expected to enter into chemical combination with the ingredients of soils, while ammonia is usually rapidly absorbed by them, so that the fluids left behind are almost free from it. Our researches have indeed corroborated this opinion: *urea is not absorbed by soils, but totally left in solution.*

"Human urine contains about 2 per cent of urea, and even when diluted with an equal bulk of water (as farmers do) it still represents so strong a solution that plants cannot live in it. The agricultural plants grow best in nutritive solutions containing ¼ to ½ part of nutrients per 1000 parts of water, while the diluted urine as applied in Japan contains still 10 parts of urea per 1000 parts of water, besides a fair proportion of common salt and sulphates, which are, as we know, likewise not absorbed by soils.

"The injurious effect exerted by too strong nutritive solutions consists, as is commonly known, in preventing or hindering the diffusion of water from the soil into the roots: hence the plants wilt.

"The conversion of urea into ammonium carbonate is accomplished, within a few days, as well when the excreta are kept in air as when put into soils. As this process is, however, performed by lower organisms (bacteria and micrococci), and as the latter can live but near the surface of soils where oxygen is present, it was expected that in a certain depth of the ground urea may not be altered.

"Researches, made with every possible precaution to prevent the access of atmospheric germs into the solutions and bottles, have indeed shown that, even in the porous soil of Komaba (volcanic ash), *ammonification can be performed only to a depth of 60 centimetres.*

"Urea solutions kept in contact with samples of soil taken from depths of 60 to 65, 120 to 125, 150 to 155 c.m. did not contain any trace of ammonia after a lapse of two months, while surface soils (0 to 5 c.m.) speedily converted the whole of urea employed, so that after sixteen days no more urea could be found. The next layer, taken from a depth of 25 to 30 c.m., accomplished the conversion far more slowly, so that this process was not yet completed after two months.

"Farmers, using fresh urine, run consequently the risk not only of injuring their crops, but also of losing a great deal of the most valuable nitrogenous compound of this manure by rain, which carries the urea into deep sub-soils beyond the reach of the roots of plants.

"The results of these researches are valid not only with regard to human excreta, but also, to a certain extent, with reference to the urine of the live stock."

The CHAIRMAN, in proposing a vote of thanks to the lecturers, referred to the very great interest and much practical importance which attaches to Dr. Kellner's experimental work.

The formal part of the meeting having been terminated, the guests and the members then adjourned to the dining room, which, owing to the hospitality of the officers of the Botanical Garden, was largely and elegantly supplied with rare and beautiful botanical specimens.

One interesting and important feature of the day was the exhibition of new and interesting chemical compounds obtained by the members during the year, and of new pamphlets, books, apparatus, and other objects of chemical interest. This chemical exhibition, inaugurated on the occasion of the sixth annual meeting in 1884, has always proved to be of great success, as on the present occasion, and has, moreover, served as a good means of encouraging original work among the members.

NOTICES OF BOOKS.

Chemistry for the Gold Fields: Including Lectures on the Non-metallic Elements, Metallurgy, and the Testing and Assaying of Metals, Metallic Ores, and other Minerals, by the Test-tube, the Blowpipe, and the Crucible. By JAMES G. BLACK, D.Sc., Professor of Chemistry, Metallurgy, and Assaying in the University of Otago and the Otago School of Mines. Dunedin: Horsburgh.

THE peculiar character of this book, as we learn from the preface, is that "while dealing lightly and very generally with the non-metallic elements and with those departments of chemistry which have no immediate bearing on the pursuits of the miner, it treats pretty fully such subjects as have a direct reference to the mineral resources of the country." In other words, we have here a treatise on chemistry for miners, and more especially for gold miners.

It need scarcely surprise us, therefore, to find certain elements omitted. But we might expect to find a notice of tellurium, which frequently accompanies gold, and of vanadium, which possesses certain most valuable properties and is found to be much more widely diffused than it was recently supposed. The account of platinum is somewhat meagre, and its accompanying metals, palladium, rhodium, iridium, osmium, &c., are dismissed with the remark that "the remaining metals of the gold family are not of sufficient importance to require notice in this treatise." To this opinion we must venture to demur; iridium, palladium, and rhodium are decidedly useful, and if their characteristics were made known to miners and prospecters it is very possible that they might be found in larger quantities.

The author's classification of the elements is peculiar: boron and silicon, for instance, being placed among the halogens. This, however, is a matter of small importance.

Some of the atomic weights of the elements as here given are not in accordance with the most recent determinations. Thus, *e.g.* gold and platinum are both given as 196·7. In the probable case of a second edition these figures will doubtless undergo revision.

Under "carbon" we find a prolonged and eulogistic account of coal-gas, containing a number of most questionable statements. Thus, we read that gas "blazes away on its luminous path in increased 'sweetness and light,' defying for cheapness, safety, and efficiency every competitor." Now the "sweetness" of gas is, to us at least, a something unknown. Even if absolutely freed from every trace of sulphur, which is in practice impossible, its own specific odour is disgusting. As for "safety," those who have witnessed, *e.g.*, the explosion which tore up streets and wrecked houses from Charlotte Street, Fitzroy Square, to a point some distance to the east of Tottenham Court Road will form their own opinion.

But the author, warming to his subject, goes still further. He writes:—"Messrs. Murdoch and Winsor (more correctly Winzer) succeeded at last in convincing the Londoners either that the gas no longer produced the acids, stinks, and smoke complained of, or, if it did, so much the better; for these are beneficial, on the one hand, to the moral welfare of the consumers as giving occasion for exercising the virtues of patience, forbearance, and equanimity, and so forth, and to the physical health, on the other hand, as smoke is one of the best preservatives known, witness its use for curing bacon."

We do not know whether Dr. Black is here speaking seriously or joking. Nor is it clear whether he is giving his own views or merely reproducing the sophisms of Winzer, the inventor, not indeed of gas, but of gas companies. But the smoke, acids, and stinks still exist as hard facts, chemically and physically demonstrable. The plea concerning the "moral welfare of the consumers," if valid at all would justify every nuisance and nearly every evil. Patience and forbearance are surely not virtues but vices when we are placed face to face with a preventible or avoidable evil. The smoke used in curing bacon and in rendering it less digestible is not coal-smoke, but wood-smoke.

This notion of the sanitary benefits of coal gas is the more strange as, in the next section, the author, speaking of the deadly properties of carbon monoxide, writes:—"Cases of poisoning by coal-gas are, therefore, cases of poisoning by carbonic oxide. These cases are by no means of rare occurrence in large cities."

We trust that in a new edition Dr. Black will see his way to the elimination of his exaggerated praises of coal-gas, the more as it has little connection with his main subject.

The use of carbon disulphide for destroying rabbits—one of the direst plagues in Australia—is an exceedingly happy thought. Phosphorus is also extensively and successfully used in the Australian colonies for the same purpose. In the same chapter the author discusses most judiciously the waste of plant-food which has been and still is committed in all civilised countries save China and Japan. He justly denounces the folly of passing the sewage of our great cities into the sea, as we are doing and apparently intend to do here in London.

Under potassium we find no mention of what are now its chief sources, the Stassfurt group of minerals. It is very desirable that careful search for such minerals should be made in likely localities in India and in the Colonies.

In the section on copper and its ores, the electrolytic assay seems to have been overlooked.

If, in our notice of this work, we have chiefly pointed out what appear to us as errors or oversights, it is by no means due to any desire on our part to depreciate the work. On the contrary, we believe it is, in the main, a highly useful manual, which, after a more thorough revision, will deserve to take a permanent place, as a text-book, in schools of mining and metallurgy.

On the Valuation of Unexhausted Manures. By Sir J. B. Lawes, Bart., F.R.S., and J. H. Gilbert, Ph.D., F.R.S. London: Murray.

The subject of this pamphlet is as full of importance as it is of difficulties. It strikes us in the first place as a deficiency that the authors include, under the head of unexhausted manures, those substances only which have been passed through the bodies of cattle. Of bone-dust, precipitated phosphates, basic iron slags, &c., which may have been applied to the land, say, a year before the expiration of a tenancy, and the value of which may not be entirely exhausted, no account is taken. In three successive chapters the authors discuss and tabulate, first, the average composition of cattle-foods, secondly, the total or original value of consumed cattle-foods, and thirdly, the unexhausted manure value of cattle-foods. They propose, as regards the more nitrogenous foods, to deduct $\frac{1}{2}$ of the original manure value for the last year and $\frac{1}{4}$ from year to year. For hay and straw of whatever kind they deduct $\frac{1}{3}$ of original value the last year and $\frac{1}{6}$ from year to year.

Proceedings of the American Pharmaceutical Association at the Thirty-third Annual Meeting, held at Pittsburgh, September, 1885; Also the Constitution, By-Laws, and Roll of Members. Philadelphia: The Association.

We are first led to notice the list of queries to be answered at the meeting in September next. Among these we notice a question as to the best practical method of determining melting-points; a demand for a plan for the perfect separation of the alkaloids, and for tests for brucine and strychnine when jointly present; and a good process for determining tannin. This last query is one of great interest, but we fear that it will not for some time receive a satisfactory answer.

The section on the Progress of Pharmacy is extensive and contains much important matter, though doubts might arise as to the specially or exclusively pharmaceutical character of some passages. We are glad to observe the scrupulous care of the compilers in stating the original source from which each paragraph or abstract has been obtained.

Considerable attention has evidently been paid to legislation concerning the sale of poisons. The "Pharmacy Law" of Kansas arranges a number of articles in two schedules, in the second of which figure the mineral acids! The sale of these articles, except to "practising physicians and photographers," is encumbered with a variety of formalities. We might suggest that an analytical chemist is surely as much entitled to special consideration as a photographer, and further that the proscription of "poisons" in a country where explosives and ammunition are freely dispensed to all comers is a somewhat needless precaution.

There are further special reports and essays on pharmacy, on chemistry, and on materia medica. In the first-mentioned section there is a note on fungoid growths in dilute phosphoric acid. Singularly enough the same percentage of free acid is found in such acids after the fungus has grown as there was previously.

In the section on chemistry we find a notice of the gross adulteration of stibnite or antimony sulphide. Whilst certain samples consisted of the natural antimony ore in a powdered form, others, in fact nine out of fifteen of the samples, showed "no trace of antimony by the tests of the pharmacopœia," but consisted of coal-dust and powdered limestone!

In the chapter on Materia Medica is a paper on the "Exportation of American Drugs." Here we find a statement doubtless true, but which reflects little credit to the British public. "England led all the other nations in her purchases of (American) patent medicines, having bought the enormous sum of 397,389 dollars' worth."

So in these days the demand for quackery far exceeds the native supply!

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxii., Part 3.

Atomic Weights of Cobalt and Nickel.—Clemens Zimmermann (edited by Alibegoff and Krüss).—The author finds for cobalt the atomic weight 58·742 (O = 15·96), or 58·89 if O = 16. The properties of pure cobaltous oxide are given as follows:—The oxide has a light brown colour and is non-magnetic. If heated on platinum foil over a single flame it is rapidly converted into a higher black oxide. Even after two months' exposure to the air it does not undergo the slightest change of weight. The oxide is gradually dissolved by acids, the solution being rose-coloured. Strong hydrochloric and sulphuric acid dissolve it with a blue colour. Ammonia has no action, even in heat. Hot solution of ammonium chloride takes up cobaltous oxide with a deep blue colour, whilst ammonia is liberated. On cooling the liquid assumes a red colour. The behaviour of ammonium sulphocyanide is similar. Dilute alkaline solutions have no action upon cobaltous oxide. Strong potassa or soda-lye, if hot, dissolve cobaltous oxide with a deep blue colour; on dilution with water cobaltous hydroxide is deposited and is quickly oxidised, turning brown. The atomic weight of nickel is = 58·557 if O = 15·96, or 58·705 if O = 16. Nickel monoxide has a fine light green colour and is not magnetic. If heated on platinum foil it takes a deep yellow colour, but the green returns on cooling. In hot hydrochloric acid, strong or weak, the monoxide dissolves with a green colour, without the slightest evolution of chlorine. Nitric acid, if hot, dissolves nickel monoxide with a green colour. Sulphuric acid, with the aid of heat, dissolves nickel monoxide slowly; the solution is yellow. Hot perchloric acid dissolves the monoxide slowly with a green colour; in the cold there is no action. Acetic acid does not dissolve nickel monoxide, even on prolonged boiling. In a solution of ammonium chloride the oxide is also almost insoluble on prolonged boiling, and in ammonium sulphocyanide it is insoluble. The strongest soda-lye, even with the aid of heat, has no action upon nickel monoxide, but it is readily taken up by melting sodium sulphate, forming a dark brown melt which turns yellow on cooling, and dissolves in water with a green colour. By the above researches it is demonstrated that the atomic weights of cobalt and nickel, though closely approximating, are yet not identical. This fact is in accordance with the requirements of the periodic system. As regards the relations of the values 58·742 and 58·557 to Prout's hypothesis, they supply fresh confirmation of its untenable character.

Method for Separating and Determining Zirconium.—Dr. G. H. Bailey.—The preparation of zirconium free from traces of other elements is very difficult, especially in presence of iron, titanium, niobium, and some other rare elements. For the determination of zirconium in minerals which contain it merely in traces there is, hitherto, no good method. It is by no means impossible that zirconium may be more widely diffused in minerals than experience has hitherto shown. Hydrogen peroxide supplies a means of separation. Its very dilute solutions produce no precipitate, but with a moderately concentrated solution the precipitation is perfect. Clève has already shown that it does not throw down iron and alumina. Titanium occasions a colouration from which the formation of a higher oxide may be inferred, but there is no precipitation. From a solution containing titanium salts zirconium may, therefore, be thrown down quite free from titanium. Niobium and tantalum seem, likewise, to form no precipitates with hydrogen peroxide, as is also the case with tin and silicium. The above-mentioned elements are those which generally occur together with zirconium, and are difficult to separate according to the ordinary method. Hydrogen peroxide of such a strength that it yields 120 vols. oxygen, throws down Zr_2O_5 at once and completely from a solution of zirconium in excess of sulphuric acid. The author is engaged with the further study of this method.

Notes on an Analysis of Koppite.—Dr. G. H. Bailey.—The specimen in question was obtained from Kaiserstuhl, and contained niobium, titanium, zirconium, cerium, lanthanum, and didymium, besides iron, calcium, magnesium, sodium, potassium, and fluorine. Thorium was not present.

Some New Vanadium Compounds.—J. T. Brierley.—The author has obtained five salts containining different quantities of the two vanadium oxides V_2O_4 and V_2O_5.

Die Chemische Industrie.
Vol. ix., No. 3, March, 1886.

The Application of the Spectroscope in the Manufacture of Aniline Colours.—Dr. Paul Schoop.—The author recommends quantitative spectral analysis as the best method for ascertaining the tinctorial strength and the tone of a colouring-matter. He proposes a simpler and less costly modification of the apparatus of Krüss. He considers that spectral analysis will solve certain very important theoretical questions, *i.e.*, ascertain the influence of a substituted radicle or of certain groups of atoms upon the intensity of a colour.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 9, May 1, 1886.

The Oxidation of Sebacic Acid.—H. Carette.—The oxidation of sebacic acid yields succinic, adipic, and iso-pyrotartaric acid.

Detection of Coal-Tar Reds in Wines by means of Metallic Oxides.—P. Cazeneuve.—Already noticed.

A New Tannin.—The use of valonia nuts appears to be rare or unknown in France, though common in the rest of Europe.

Detection of Cochineal, Phytolacca decandra, Beetroot, and Orchil in Wines.—M. Bellier.—For the three former colouring-matters the author employs an intimate and finely powdered mixture of stannous chloride and borax, both previously dried. For orchil the reagent is a similar mixture of borax and of lead acetate. The method of operation is as follows:—About 10 c.c. of wine are poured into a test-tube, and a pinch of the tin-borax mixture is added. The whole is shaken up, heated to a boil, and filtered. If neither cochineal, *Phytolacca*, nor beet-root is present, the filtrate is colourless or faintly yellow. If it contains any of the three, it is more or less deeply red. To distinguish cochineal from the two others a few drops of ammonia are added to the filtrate, and the mixture is boiled. Cochineal is thus turned to a more violet tone, whilst *Phytolacca* and beet-root are decolourised and become yellow. If the filtrate has only a faint rose-colour, instead of ammonia there are added to it a few drops of sulphuric acid, a little amylic alcohol, and the whole is shaken up. The cochineal passes into the amylic alcohol and colours it red: the *Phytolacca* and beet-root do not pass over, and the amylic alcohol remains colourless. For the detection of orchil the author proceeds in exactly the same manner. Wine coloured with orchil has, after treatment and filtration, a violet colour. Natural wine runs through the filter colourless or slightly yellowish. In examining an unknown wine the tin-borax reaction should be tried first, and, before both reactions, it is well to ascertain with the mixture of mercuric acetate and magnesia that no coal-tar colour is present.

The "Velo-Porphyre," a New Pharmaceutical Apparatus. — B. Giraud. — The apparatus in question cannot be intelligibly described without the two accompanying figures.

Moniteur Scientifique, Quesneville.
3rd Series, Vol. xvi., May, 1886.

Review of various Chemical Researches.—Abstracts of papers from the Chemical News.

The Derivatives of Hexa-oxybenzine and their Relations with Croconic and Rhodizonic Acids.—MM. Nietzki and Benckiser.—From the *Berichte der Deutsch. Chem. Gesellschaft.*

Enrichment of Coal-Gas with Certain Hydrocarbons.—G. E. Davis.—A paper read read before the London Section of the Society of Chemical Industry, Jan. 4, 1886.

Explosion of Homogeneous Gaseous Mixtures.—Dugald Clerk.—A paper read at the meeting of Civil Engineers, Feb. 9, 1886.

Agreement entered into by the Manufacturers of Manures and the Agricultural Stations of South Germany for Converting and Unifying the Bases of the Determination of the Commercial Value of Superphosphates and Precipitated Phosphates.—Professor Paul Wagner.— From the *Chemiker Zeitung*, 1886, pp. 1, 19, 37. It has also appeared in the Chemical News, liii., p. 133.

Notes on Quinine Hydrate.—F. W. Fletcher.

Cocaine and its Salts.—Dr. B. H. Paul.—These two papers have evidently appeared in some English journal.

Attempt at a Qualitative Analysis of the Colouring-Matters met with in Commerce.—Dr. O. N. Witt.—Already noticed under *Chemische Industrie*, from which it has been translated.

Artificial Colouring-Matters applied in Manufactures. — (Fourth Lecture). — Dr. E. Noelting. — This lecture is devoted to the phthaleines and to artificial indigo. The lecturer admits that the problem of an artificial indigo, capable of competing with the natural product, has not yet been solved.

On Electrolytic Theories. — G. Chicandard. — An abstract of a memoir by Prof. Gonzalvo Guimaraes, of the University of Coimbra. The author admits that the chemical atoms are aggregates of elementary atoms, equal among themselves and possessing the same quantity of *vis viva*, and that the laws which govern the combinations of chemical atoms govern likewise the aggregations of chemical atoms. From *à priori* considerations he arrives at the following conclusion: the force necessary to decompose a compound molecule is the same as that which dissociates any other molecule whatever provided that the radicles of each are of the same atomicity. Thus, when a current traverses two voltameters containing, the first a solution of ferric sulphate and the second one of aluminium sulphate, the weights of each electrolyte decomposed in a given time are as their respective molecular weights. Thus the quantity of electricity sufficient to decompose the molecule of aluminium sulphate will decompose 3 mols. zinc sulphate, 3 mols. potassium sulphate, or 6 mols. potassium nitrate. These considerations render it possible to establish the two following propositions, which both agree with the electrolytic law:—1. When an electric current traverses several electrolysible substances the ponderable quantity decomposed is, for each of them, proportional to the molecular weight and inversely proportional to the atomicity which the ions had in the molecule. 2. Each *electro-atomy* decomposes a fraction of molecular weight of which the numerator is equal to unity and the denominator to the atomicity which the ions had in the molecule. The author proposes the word *electro-atomy* as a substitute for that of "equivalent of electricity," which he regards as belonging to an obsolete notation. According to Prof. Guimaraes these two propositions are applicable not merely to the oxides and metallic salts, but to all compounds, inorganic or organic, of which the electrolysis has been effected.

Industrial Society of Mulhouse: Chemical Committee.—Session of March 10.—M. Weber communicated the sequel of his researches on the red colouration taken by pieces of cotton exposed to the vapours of commercial aniline. He finds that pieces which, in the raw state, are of the deepest colour take the most decided rose tint. The red colour upon bleached calico is, strange to say, the more decided the more thoroughly it has been treated with chlorine in bleaching. A cloth which has undergone all the other operations of bleaching without chlorine does not show this colour. The rose tint does not come from traces of chlorine remaining in the tissue, since it is produced with equal intensity if, after the last chlorination, it is taken through sodium bisulphite. An energetic treatment with soda at a boil after the chlorine prevents the reddening entirely. The chlorinised tissue which reddens under the influence of aniline vapours is found to have acquired the property of attracting basic colours more strongly than ordinary cotton, whilst it manifests no affinity for dyes of an acid or phenolic character.

G. Galland sent in researches on the colours derived from benzidine, with reference to their power of acting as mordants for the basic colours.

Supplementary Session, March 26.—C. Kœchlin, with reference to Schœn's paper on apparatine, remarked that very strong soda-lyes do not affect starch, which dissolves in dilute lyes.

M. Dépierre sent in a paper on the manufacture of white-metal cylinders for printing, covered with copper by the galvano-plastic process.

L. Durand, of the firm Durand and Huguenin, of Bâle, addressed to the committee a letter on the history of resorcine green.

Preparation of Sublimed Oxalic Acid.—H. Hussenot.—The author proposes a modification of Hampe's process.

MEETINGS FOR THE WEEK.

Wednesday, 16th.—Meteorological, 7.
Thursday, 17th.—Chemical, 8. Ballot for the Election of Fellows. (For List of Papers to be read see p. 284).
— Royal Society Club, 6.30. (Anniversary).

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5. On Building Materials. Four Lectures by W. G. Dent, F.C.S., F.I.C., on July 26th, 27th, 29th, and 30th, at 7.30 p.m. Fee 5s.

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PHILIP MAGNUS.
Director and Secretary.

THE CHEMICAL NEWS.

Vol. LIII. No. 1386.

THE SUPPOSED ERROR IN THE NITROMETRIC ASSAY OF VITRIOL.

By G. LUNGE.

In his last communication (Chemical News, vol. liii., p. 266) Mr. Thomas Bayley admits that he was mistaken in attributing the power of retaining nitric oxide to the solution of mercurous sulphate in sulphuric acid, contained in the nitrometer. But he still upholds that an error is committed, owing to the presence of *iron*. In support of this he quotes several experiments, made with solutions of ferrous sulphate in pure concentrated sulphuric acid, and one with a sample of Glover acid, containing 0·05 per cent Fe. Unfortunately it did not occur to him to try that substance which alone was in question, viz., nitrous vitriol, or indeed anything containing either nitrous or nitric acid *beforehand*, instead of mixing the substances only within the nitrometer. He would then have found that no error could possibly have arisen from the presence of iron, since only proto-salts of iron dissolve NO, and no proto-salt of iron can exist in the presence of nitrous or nitric acid! That the "pure" concentrated sulphuric acid added in the experiment should in any practical case contain an appreciable quantity of iron, sufficient to dissolve NO, is a most unlikely assumption, for which not a tittle of proof is given, and that this iron should exist in the shape of proto-salt is still more bordering on the impossible. Anything of the kind would be shown by the brown colour of NO dissolved in $FeSO_4$, which Mr. Bayley himself points out as an extremely delicate reaction, but which I, for my part, have never observed in testing nitrous vitriol, and of which Mr. Bayley himself, no more than anybody else, has ever spoken as occurring in that case. If it did occur such a test would, of course, be rejected.

For the future I must decline to waste your readers' and my own time with a subject worn threadbare now. If there is anybody still convinced that Mr. Bayley has proved the alleged error in using the nitrometer, I leave him to his belief.

Although I am no lover of priority disputes, I do not like passing over the way in which Mr. Bayley seeks to detract from my little merits concerning the nitrometer. He talks of "the original (Davis's) two-way nitrometer, and the three-way instrument (introduced by Lunge)." The simple facts of the case are these:—The principle of the method in question has been indicated by W. Crum a very long time ago, and later on it has been used by Frankland and Armstrong, who employed a tube open at the bottom, at the top surmounted by a simple stop-cock and cap. Mr. G. E. Davis drew attention to this method for the testing of nitrous vitriol, but he continued using the Frankland tube, with a somewhat smaller mercury-trough. In this shape Crum's method was still very inconvenient, certainly unfit for general introduction among technical chemists, especially as nobody had taken the trouble to verify whether it yielded accurate results with such substances as it is now principally employed for. I supplied the deficiency by devising a piece of apparatus which dispenses with a mercury-trough, which admits of much easier—and yet decidedly more accurate—manipulation than the Frankland tube, and with which, by means of the three-way cock, you may finish a test, clean out the tube, and be ready for the next test in a few minutes. I also took the trouble of proving, by methods devised by myself, that the method and its manipulation is accurate for the testing of commercial, impure, nitrous vitriol. Lastly, I invented for my offspring the name "Nitrometer." All this I published in the *Berliner Berichte*, vol. xi., p. 436, the date of arrival at Berlin being stated —March 6, 1878 (*comp.* Chemical News, July 12, 1878, vol. xxxviii., p. 19). A couple of months after this, when travelling in England, I met Mr. G. E. Davis, and saw him using the same apparatus he had previously described —that is, a Frankland tube in a mercury-trough, nothing else. Only in 1882 (June 5th) Mr. W. J. Lovett described, in the *Journal of the Society of Chemical Industry*, 1882, p. 211, an apparatus, somewhat similar to mine, as "Davis's Nitrometer." Previously to this, but nine months after me,—on December 19th, 1878,—Mr. Starks had also described a "Nitrometer" (avowedly borrowing my word) in the *Transactions of the Newcastle Chemical Society*, vol. iv., p. 189 (Chemical News, April 18, 1879, vol. xxxix., p. 168). Now I do not object to Messrs. Davis and Starks adopting a name invented by me; nor do I mean to tax these gentlemen with having borrowed my idea, which, indeed, they would have done very imperfectly, as Davis's two-way cock is a great step backwards against my three-way cock, and Starks's instrument wants a "level-tube." I do not doubt that they had used their apparatus before they became aware of my publication; but I must insist that the "original nitrometer," both in name and in substance, is *mine*, and that Davis's and Starks's less perfect instruments were given to the world, and presumably invented later than mine.

Zürich, June 9, 1886.

PEROXIDES OF POTASSIUM AND SODIUM A LECTURE EXPERIMENT.

By H. CARRINGTON BOLTON.

The peroxide of potassium, K_2O_4, and the peroxide of sodium, Na_2O_2, were known to Gay-Lussac and Thénard* as early as 1810, by whom they were obtained in minute quantities in various ways. They have been analysed and closely studied by Vernon Harcourt,† who prepared them by burning the respective metals in dry oxygen gas.

I have devised a simple method for exhibiting to a class the formation and some of the characteristics of these peroxides. In a test-tube suspended by a wire from an iron stand, a quantity of potassium nitrate is melted over a Bunsen burner, and heated until oxygen gas is freely liberated; on dropping into the melted nitrate small pellets of clean potassium, the metal burns with a bright light, and forms the yellowish peroxide: this gradually sinks beneath the surface of the melted mass and dissolves therein, communicating to the whole a deep, rich, red colour: the colour is easily shown by the aid of transmitted light. On allowing the melted mass to cool and solidify, the colour disappears, but reappears on again applying heat.

If sodium nitrate and metallic sodium be used similar phenomena are observed, but the solution of the peroxide has a yellowish red colour. The action of sodium on melted saltpetre produces a brown-red solution quite intense when sufficiently heated. On cooling, in each case the mass loses its colour.

These reactions are quite consistent with the properties of the peroxides as described by Harcourt. Potassium peroxide, he says, is "deep orange-yellow, and fuses to a black fluid"; sodium peroxide is white when cold, becomes "full yellow" on heating, and when fused is "black while hot, brown on cooling." Moreover we prepared a small quantity of sodium peroxide in the usual way, by burning the metal in dry oxygen, and ascertained that it dissolves in melted saltpetre with the characteristic colouration.

* "Recherches Physico-Chimiques," i., 132.
† *Quart. J. Chem. Soc.*, xvi., 267 (1861).

The colourless mass resulting from any of the above reactions forms, of course, a strong alkaline aqueous solution: this yields, with copper sulphate, a greenish precipitate which is evidently a mixture of blue cupric hydrate and of the yellow peroxide of copper, formed, according to Brodie, when alkaline peroxides react on salts of copper.*

On attempting to examine the action of sodium on melted chlorate of potassium a violent explosion occurred, projecting fragments of the test-tube and the melted salt into the face and over the person of the operator. The explosion was instantaneous, and accompanied by a loud report. On repeating this with suitable precautions, using a stouter tube surrounded by a metallic cylinder, similar explosions resulted, without, however, breaking the glass. Pellets of sodium no larger than a grain of barley cause sharp reports the moment they reach the surface of the melted chlorate. Serious accidents might result from incautious experimentation with these materials should the treacherous character of chlorates be overlooked.

As a lecture experiment the action of potassium on the nitrate is instructive, and will do much to dispel the impression, often left on the minds of students, that the alkaline metals form coloured compounds only with acids having chromatic radicals.

ON THE PLACE OF ORIGIN OF URIC ACID IN THE ANIMAL BODY.†

By ALFRED BARING GARROD, M.D., F.R.S.

The endeavour of the author in this communication has been to show the place of origin of uric acid in the animal body, and to ascertain which of the two hypotheses on the subject is correct, viz., whether uric acid is first present in the blood and then secreted from the blood by the kidneys, or whether it is formed by the kidneys themselves. To enable him to satisfactorily prosecute many of his observations the author has devised a new method for discovering the presence of uric acid in very minute quantities of blood.

The results of his investigations are embodied in the form of the nine following propositions:—

Prop. I.—Uric acid is secreted by the kidneys as ammonium urate, and in the case of birds and reptiles, whose urine is semi-solid, it is found in a definite physical form, more in the vitreous condition than in the truly crystalline shape.

Prop. II.—Uric acid, when present in the blood, is found under the form of sodium urate, and, when deposited from the blood during life in any tissue, it is also as sodium urate in its characteristic crystalline form.

Prop. III.—The daily quantity of uric acid in relation to their body-weights secreted by different animals varies extremely. In some, as the carnivorous mammalia, the ratio may be less than 1 to 1,000,000, whereas, in others, as birds, it may be as 1 to 85. In man it may be regarded as about 1 to 120,000.

Prop. IV.—The quantity of uric acid contained in the blood of different animals has little relation to that secreted by the kidneys. In birds, secreting daily so large a quantity, the blood is often found to be as free from uric acid as it is in animals whose daily elimination of uric acid is excessively small.

Prop. V.—When uric acid is absorbed from the alimentary canal the blood becomes strongly impregnated, and, in fact, often almost saturated with it, so that its presence is readily discovered by any ordinary test.

Prop. VI.—One cause of the appearance of an unusual quantity of uric acid in the blood of birds in health is the presence of uric acid in the water they drink, and occasionally in their solid food.

Prop. VII.—When uric acid is taken into the stomach of man, or other animals, the secretion of this principle from the kidneys is not increased, although at the time the blood may be rich in it.

Prop. VIII.—Uric acid is found in varying quantities in the blood obtained from different veins in the same animal. It is found in larger quantity in that from the efferent renal veins than in that from the portal afferent, or from the jugular veins; and the same test which freely exhibits uric acid in the blood from the former, often fails to show it at all in that from the latter two.

Prop. IX.—The quantity of uric acid secreted daily by the kidneys of a bird is in close relation to the quantity of nitrogenised food taken during the time.

Having brought forward proofs to confirm these propositions severally, the author draws the following conclusion, viz., that every argument is in favour of the hypothesis that uric acid is formed by the kidney-cells, in the form of ammonium urate, and that the traces of sodium urate found in the blood are the result of a necessary absorption, slight in amount, of the ammonium urate from the kidneys into the blood, and its subsequent conversion in that fluid into sodium urate.

FLAME CONTACT.
A NEW DEPARTURE IN WATER HEATING.*

By THOMAS FLETCHER, F.C.S.

It is my intention to prove to you, on theoretical grounds, and also by experimental demonstration, in such a manner as will admit of no possible doubt, that the present accepted system of water heating, by gaseous or other fuel, is a very imperfect means for an end, and is, both in theory and practice, essentially faulty. My statements may appear bold, but I come prepared to prove them in a manner which I think none of you will question, as the matter admits of the simplest demonstration. I will, in the first place, boil a specified quantity of water in a flat-bottomed vessel of copper; the time required to boil this you will be able to take for yourselves, as the result will be visible by the discharge of a strong jet of steam from the boiler. I will then take another copper boiler of the same form, but with only one-half the surface to give up its heat to the water, and will in this vessel boil the same quantity of water with the same burner in a little over one-half the time, thus about doubling the efficiency of the burner, and increasing the effective duty of the heating surface nearly four-fold, by getting almost double the work from one-half the surface.

The subject is a comparatively new one, and my experiments are far from complete on all points, but they are sufficiently so to prove my case fully. As no doubt you are all aware, it is not possible to obtain flame contact with any cold, or comparatively cold, surface. This is readily proved by placing a vessel of water with a perfectly flat bottom over an atmospheric gas-burner; if the eye is placed on a level with the bottom of the vessel a clear space will be seen between it and the flame. I cannot show this space on a lecture table to an audience, but I can prove its existence by pasting a paper label on the bottom of one of the boilers, and exposing this to the direct impact of a powerful burner during the time the water is being boiled, and you will see that it comes out perfectly clean and uncoloured. Now it is well known that paper becomes charred at a temperature of about

* *Proc. Roy. Soc.*, xii., 209.

† Abstract of a Paper read before the Royal Society, June 10, 1886.

* Gas Institute Meeting, London, June 9th, 1886.

400° F., and the fact that my test-paper is not charred proves that it has not been exposed to this temperature, the flame being in fact extinguished by the cooling power of the water in the vessel. I need hardly remind you that the speed with which convected or conducted heat is absorbed by any body is in direct ratio to the difference between its own temperature and that of the source of heat in absolute contact with it; and, therefore, as the source of the heat taken up by the vessel is nothing but unburnt gases, at a temperature below 400° F., the rate of absorption cannot, under any circumstances, be great, and the usual practice is to compensate for this inefficiency by an enormous extension of surface in contact with the water, which extension I will prove to you is quite unnecessary. You will see I have here a copper vessel with a number of solid copper rods depending from the lower surface; each rod passes through into the water space and is flattened into a broad head, which gives up its heat rapidly to the water. My theory can be stated in a few words: The lower ends of the rods, not being in close communication with the water, can, and do attain, a temperature sufficiently high to admit of direct flame contact, and as their efficiency, like that of the water surface, depends on the difference between their own temperature and that of the source of heat in absolute contact with them, we must, if my theory is correct, obtain a far greater duty from them. I do not wish you to take anything for granted, and although the surface of the rods, being vertical, can only be calculated for evaporating power at one half that of a horizontal surface, as is usual in boiler practice, my margin of increased duty is so great, that I can afford to ignore this, and to take the whole at what its value would be as horizontal surface, and still obtain a duty 50 per cent greater from a surface which is the same in area as the flat-bottomed vessel on the fire side, but having only one-third the surface area in contact with the water. I do not, of course, profess to obtain more heat from the fuel than it contains, but simply to utilise that heat to the fullest possible extent by the use of heating surfaces, beyond comparison smaller than what have been considered necessary, and to prove not only that the heating surfaces can be concentrated in a very small area, but also that its efficiency can be greatly increased by preventing close water contact, and so permitting combustion in complete contact with a part of the heating surface. I will now boil 40 ounces of water in this flat-bottomed copper vessel, and, as you will see, sharp boiling begins in 3 minutes 15 seconds from the time the gas is lighted. The small quantity of steam evolved before this time is of no importance, being caused partly by the air driven off from the water and partly from local boiling at the edges of the vessel owing to imperfect circulation. On the bottom of this vessel is pasted a paper label which you will see is untouched by the flame owing to the fact that no flame can exist in contact with a cold surface.

It may be thought that, owing to the rapid conducting power of copper, the paper cannot get hot enough to char. This is quite a mistake, as I will show you by a very curious experiment. I will hold a small plate of copper in the flame for a few seconds, and will then hold it against the paper. You will see that, although the copper must of necessity be at a temperature not exceeding that of the flame, it readily chars the paper. We can, by a modification of this experiment, measure the depth of the flameless space, as the copper, if placed against the paper before it has time to be previously heated, will, if not thicker than 1-40th inch, never become hot enough to discolour the paper, showing that the flame and source of heat must be below the level of a plate of metal this thickness.

In repeating this experiment I must caution you to use flour paste, not gum, which is liable to swell and force the paper past the limit of the flameless space, and also to allow the paste to dry before applying the flame, as the steam formed by the wet paste is liable also to lift the paper away and force it into the flame. I will now take this vessel, which has only one-half the surface in contact with the water, the lower part being covered with copper rods, 3-16th inch diameter, ¼ inch centres apart, and 1¼ inch long, and you will see that with the same burner as before, under precisely the same conditions, sharp boiling takes place in 1 minute 50 seconds, being only 13 seconds more than half the time required to produce the same result with the same quantity of water as in the previous experiment. Although the water surface in contact with the source of heat is only one-half that of the first vessel and the burner is the same, we can see the difference not only in the time required to boil the 40 oz. of water, but also in the much greater force and volume of steam evolved when boiling does occur. With reference to the form and proportions of the conducting rods, these can only be obtained by direct experiment in each case for each distinct purpose. The conducting power of a metallic rod is limited, and the higher the temperature of the source of heat, the shorter will the rods need to be, so as to ensure the free ends being below a red heat, and so prevent oxidation and wasting. There are also other reasons which limit the proportions of the rods, such as liability to choke with dirt and difficulty of cleaning, and also risk of mechanical injury in such cases as ordinary kettles or pans; all these requirements need to be met by different forms and strengths of rods to ensure permanent service, and, as you will see further on, by substituting in some cases a different form and type of heat conductor. To prove my theory as to the greater efficiency of the surface of the rods in contact with the flame as against that in direct contact with the water, I have another smaller vessel which, including the rods, has the same total surface in contact with the flame, but only one-third the water surface as compared with the first experiment. Using again the same quantity of water and the same burner we get sharp boiling in two minutes ten seconds, being an increase of duty of 50 per cent, with the same surface exposed to the flame. The rods in the last experiment form two-thirds of the total heating surface, and if we take, as I think for some careful experiments we may safely do, one-half the length of the rods to be at a temperature which will admit of direct flame contact, we have here the extraordinary result that flame contact with one-third of the heating surface increases the total fuel duty on a limited area 50 per cent. This really means that the area in contact with flame is something like six times as efficient as the other. In laboratory experiments it is necessary not only to get your result, but to prove your result is correct, and the proof of the theory admits of ready demonstration in your own laboratories although it is unfit for a lecture experiment, at all events in the only form I have tested it. If you will take two ordinary metal ladles for melting lead, cover the lower part of one of these with the projecting rods or studs and leave the other plain, you will find on melting a specified quantity of metal in each that the difference in duty between the two is very small. The slight increase may be fully accounted for by the difference in the available heating surface reducing the amount of waste heat passing away, and this proves that flame contact, and therefore quick absorption of heat, takes place on plain surfaces as soon as these are above a certain temperature, which, in a metal ladle, very soon occurs. What the temperature is which admits of flame contact I have, as yet, not been able to test thoroughly, and it will need some consideration how the determination of this is to be correctly made; at the same time it is a question in physics which should be capable of being answered.

Let us now take the other side of the question. If the efficiency of a surface depends on flame contact there must of course be flame, or at least gases of an extremely high temperature, and we therefore cannot expect this extraordinary increase of efficiency in any part of our boiler except where flame exists, and if these projectors are placed in a boiler, anywhere except in contact with

flame, their efficiency must be reduced to that of ordinary heating surface. They are, of course, useful, but only in the same way as ordinary flue surface. When we come to boilers for raising steam, which have to stand high pressures, we come to other difficulties of a very serious nature, which require special provision to overcome them. To put such rods as I have referred to in a boiler-plate necessitates the plate being drilled all over holes, causing a dangerous source of weakness, as the rods cannot be used as stays; further than this, they would render really efficient examination a matter of extreme difficulty, and would be liable to give rise to frequent and almost incurable leakages; but there is, fortunately, a very simple way to overcome this difficulty. I have found that rods or points, such as I have described, are not necessary, and that the same results can be obtained by webs or angle-ribs rolled in the plates. My experiments in this direction are not complete, and at present they tend to the conclusion that circular webs, which would be of the greatest efficiency in strengthening the flues, are not so efficient for heating as webs running lengthwise with the flue, and in a line with the direction of the flame. This point is one which I am at present engaged in testing with experimental boilers of the Cornish and Lancashire type, and as, with gas, we have a fuel which renders every assistance to the experimenter, it will not take long to prove the comparative results obtained by the two different forms of web. Those of you who have steam boilers will, no doubt, know the great liability to cracking at the rivet-holes in those parts where the plates are double. This cracking, so far as my own limited experience goes, being usually, if not always, on the fire side, where the end of the plate is not in direct contact with the water,—where it is, in fact, under the conditions of one of the proposed webs,—I think we may safely come to the conclusion that this cracking is caused by the great comparative expansion and contraction of the edge of the plate in contact with the fire; and it will probably be found that if the plates are covered with webs, the whole of the surface of the plates will be kept at a higher and more uniform temperature, and the tendency to cracks at the rivet-holes will be reduced. This is a question not entirely of theory, but needs to be tested in actual practice.

There is another point of importance in boilers of the locomotive class, and those in which a very high temperature is kept in the fire-box, and this is the necessity of determining by direct experiment the speed with which heat can safely be conducted to the water without causing the evolution of steam to be so rapid as to prevent the water remaining in contact with the plates, and also whether the steam will or will not carry mechanically with it so much water as to make it objectionably wet, and cause priming and loss of work by water being carried into the cylinders. I have observed in the open boilers I use, that when sufficient heat is applied to evaporate one cubic foot of water per hour from one square foot of boiler surface, the bulk of the water in the vessel is about doubled, and that the water holds permanently in suspension a bulk of steam equal to itself. I have, as yet, not had sufficient experience to say anything positively as to the formation or adhesion of scale on such surfaces as I refer to, but the whole of my experimental boilers have up to the present remained bright and clean on the water surface, being distinctly cleaner than the boiler used with ordinary flat surfaces. It is, I believe, generally acknowledged that quick heating and rapid circulation prevents, to some extent, the formation of hard scale, and this is in perfect accord with the results of my experiments. The experiments which I have shown you, I think, demonstrate beyond all question that the steaming power of boilers in limited spaces, such as our sea-going ships, can be greatly increased; and when we consider how valuable space is on board ship the matter is one worthy of serious study and experiment. It may be well to mention that some applications of this theory are already patented.

I will now show you as a matter of interest in the application of coal gas as a fuel how quickly a small quantity of water can be boiled by a kettle constructed on the principle I have described, and to make the experiment a practical one I will use a heavy and strongly made copper kettle which weighs 6½ lbs., and will hold when full one gallon. In this kettle I will boil a pint of water, and, as you see, rapid boiling takes place in 50 seconds. The same result could be attained in a light and specially made kettle in 30 seconds, but the experiment would not be a fair practical one, as the vessel used would not be fit for hard daily service, and I have therefore limited myself to what can be done in actual daily work rather than laboratory results, which, however interesting they may be, would not be a fair example of the apparatus in actual use at present.

ON THE

DETECTION OF ADULTERATIONS IN OILS.

By OSCAR C. S. CARTER.

THE chemical examination of oils is a very important though much neglected study,—important from the fact that the oils which command a high price in the market and are in general demand are frequently adulterated. The temptation to adulterate is great on account of the heavy increase in profit, and because the adulterant is often very difficult of detection. The purchaser is always at the mercy of the oil merchant, unless the oil be submitted to a chemical examination. "Our former Consul at Naples reported to the State Department that immense quantities of refined cotton-seed oils are sent to Italy for the express purpose of sophisticating the native olive oil, for the reason that it can be brought to Naples and sold at less than half the cost of producing pure olive oil." The cotton-seed oil mixed with pure olive oil is exported to other countries. The price of fine salad oil is from 3 to 4 dollars per gallon, while cotton-seed oil is worth from 70 to 90 cents per gallon. The oils commonly used to adulterate olive oil are colza oil, sesame oil, and peanut oil. In the North of France poppy oil is used frequently because of its cheapness and neutral taste, and in Provence honey is used. In all probability glucose syrup has been tried. Linseed oil, the most important drying oil in the arts, so much used in varnishes and paints, is very often sophisticated. Even the seed from which the oil is made is mixed with other seeds. In India flax seed is grown with mustard and rape. In Russia various proportions of hemp and linseed are sown together. Hemp seed yields an oil of an acrid odour, mild taste, and yellow colour, used in Russia for burning in lamps, and making paints, varnishes, and soap. The oils commonly mixed with linseed oil are niger, cotton-seed, fish, rosin, and coal oils. In this country lard is adulterated with palm-nut and cocoanut oil; the latter is a white fat, with the peculiar smell of the kernel. It was formerly made by grinding the kernel, boiling the water, and subjecting the paste to a great pressure: a large quantity of milky juice is so obtained, which is slowly boiled, and the oil separates and is skimmed off. Twenty ordinary sized nuts yield about 2 quarts of oil. The strong taste of these oils is an objection, and may prevent their general use as adulterants and for the manufacture of oleomargarine. Lard oil, which is obtained from lard, is very valuable as a lubricant for machinery, and is also used for greasing wool in spinning. It is frequently adulterated with fish oils and cotton-seed oils. Lard oil is worth 1 dollar and 20 cents per gallon, while cotton-seed oil is worth about one-half as much.

The chemical analysis and detection of the adulterated oil is sometimes simple, but generally it is a difficult and trying task, especially when three or more oils have been mixed. The determination of the percentage of oil used

to adulterate is out of the question, and we must often be satisfied by simply proving that there has been a mixture without knowing the nature of it. But little work has been done on oils compared to the vast amount of research given to other subjects. Chemists have avoided the study and analysis of oils as difficult and uninteresting. We owe almost all we know to the labours of Chevreul, and later to the researches of Prof. Allen and others. When oils are examined, chemical tests are the more important, but the physical tests are also very useful. At the present time we have not a characteristic test for each oil, as we have for each metal, that will distinguish it when mixed with other oils or that will identify it when alone.

When we examine an oil supposed to be adulterated, much can be accomplished by procuring a sample of perfectly pure oil, and subjecting them both to the same tests and observing their behaviour. A sample of lard oil supposed to be adulterated was received from a woollen manufacturer for examination. A specimen of perfectly pure lard oil was obtained, and they were subjected to the same tests.

According to Prof. Bechi, of Florence, the following test is reliable and delicate for detecting cotton-seed oil in olive oil: the reagent is a 1 per cent solution of nitrate of silver in absolute alcohol:—Place 5 c.c. of the suspected oil in a glass flask; add to it 25 c.c. of absolute alcohol and 5 c.c. of the test solution of nitrate of silver, made as stated above. The flask is heated in a water-bath at 84° C. (direct heat must not be used). If there be any cotton-seed oil present the mixture will begin to darken, the most minute quantity serving to discolour, and the tint assumed will depend upon the amount of cotton-seed oil present. The test depends upon the fact that cotton-seed oil will reduce nitrate of silver, but olive oil will not. This reduction is also caused by rape-seed oil, but, according to Bechi, pure olive oil will remain without discolouration under this test. While experimenting with the test I thought it might be of service in detecting cotton-seed oil in lard oil; accordingly the sample of chemically pure lard oil was treated with absolute alcohol and nitrate of silver as directed, and then heated: there was not the slightest discolouration of the pure lard oil; even on standing for two weeks it did not darken, thus proving it had no action upon the nitrate of silver. The lard oil obtained from the woollen manufacturer was then tested in the same manner: when it had been heated for a few minutes it began to darken, and finally became quite black, thus proving that the lard oil was not pure, but mixed with some other oil. I am not certain that the darkening is due to reduction; having made a series of experiments with salts of mercury, copper, and antimony, and cotton-seed oil, to see if there would be any reduction, I obtained no satisfactory results, and no reduction was noticed.

The elaidin test is sometimes very satisfactory, especially in detecting a mixture of a drying and non-drying oil, and detecting adulteration of olive oil. This test depends upon the fact that olein and oleic acid in contact with peroxide of nitrogen yield a crystalline, solid, fatty body, fusible at 32° C., to which Boudet has given the name Elaidin. The nitrous vapours made by the action of nitric acid on copper are passed through the oil, or it may be shaken with a fresh solution of mercurous nitrate, which has the property of retaining nitrous acid. Non-drying vegetable oils and most animal fats contain oleic acid. The following oils contain a high percentage of olein: olive, almond, rape, arachis (earth-nut), castor, and the oils from lard and tallow. These oils form, with nitrogen peroxide, solid elaidin of a white or yellow colour, which in some cases is firm and resonant. The drying oils—such as linseed, hemp-seed, and poppy-seed oils—do not form solid elaidin with nitrous vapours, but remain liquid for more than two days, and become slightly coloured. The elaidin test was applied to the adulterated lard oil and to the pure lard oil by adding an equal amount of nitric acid (sp. gr. 1·40) and some copper turnings. The elaidin produced by the pure oil was more firm and coherent than that of the adulterated oil, and was of a lighter colour; also the nitrous fumes rose more rapidly through the pure oil. One curious fact noticed about the adulterated lard oil was, it could not be completely saponified with caustic soda; even when the latter was added in excess, a clear layer of unsaponified oil remained after several trials. This test clearly indicated adulteration, as pure lard oil will completely saponify with caustic soda. Prof. Allen has proved that shark-liver oil and African fish oil resist saponification. He tried to saponify the former oil with aqueous potash, with a solution of potash in absolute alcohol, and by heating it with solid potash, but it would not completely saponify: this he thinks is due to the fact that it contains a body allied to cholesterin, but fluid at ordinary temperatures.

Pure lard oil gives, with nitric acid of sp. gr. 1·33, a yellow colour, approaching orange.

The adulterated sample of lard oil with nitric acid of the same strength gave a distinct brown colour on standing. That portion of the oil which resisted saponification with caustic soda was treated with nitric acid, and it soon became of a deep coffee-brown colour, much darker than the above.

The determination of specific gravity is the most important of the physical tests. The viscosity of an oil is a highly important feature, but in order to be of any value in testing much care must be observed; both oils must be brought to the same temperature, and kept so while flowing. Both the adulterated and the pure lard oil were subjected to this test; they were brought to a temperature of 80° F., and 5 c.c. of each oil were passed through a capillary tube. The pure oil required 960 seconds to pass through, while the adulterated oil required 1080 seconds. The experiment was repeated several times with different tubes, but the ratio of the times of flowing was constant. Both oils were subjected to a temperature of 32° F. When the pure oil was frozen it was more coherent and firm, and much lighter in colour; the adulterated sample was quite yellow. When the adulterated oil slowly became liquid a layer of yellow oil formed first, which was quite different in appearance from the other portion, and was evidently the adulterant.

While we cannot depend on any single test, the evidence afforded by several is often conclusive and satisfactory, and in this case it was acknowledged afterwards that cotton-seed oil was one of the adulterants.—*American Chemical Journal.*

ON A

DIFFERENTIAL RESISTANCE THERMOMETER

By T. C. MENDENHALL.

THE determination or registration of the temperature at a distant or not easily accessible point, is so extremely desirable that many methods for accomplishing this end have been proposed, and to some extent made use of during the past fifty years. Naturally enough electricity has been utilised in some way or other in the majority of these systems of telethermometry.

The requirements of the problem seem to be that the device or instrument used at the point, the temperature of which is to be ascertained, shall be of the greatest possible simplicity of construction, involving little or no motion in its parts, so that the liability to "get out of order" shall be reduced to the minimum; and that at the observing or registering station the necessary appliances shall possess a maximum of durability and simplicity—so that a minimum of time and skill will be demanded in making the observations. The whole system must be certain in its indications and correct within a reasonable limit.

The first of these conditions is apparently sufficiently well satisfied by the thermo-electric-junction, which has probably been more extensively made use of than any other form of electric thermometer. It renders necessary, however, the use of a comparatively delicate galvanometer, and as the electromotive force of a single couple is small (it is difficult to use more than one in general practice) the results are subject to considerable errors arising from unknown or neglected sources of electromotive force. This source of error becomes more important as the range of temperature measured becomes smaller, although it may be almost entirely avoided by care and skill on the part of the operator. The well-known resistance method of Siemens satisfies the same condition very perfectly, and is certainly capable of giving good results when skilfully applied, at least throughout moderate ranges.

The desire to possess some form of electric-thermometer which might be utilised in the study of certain problems connected with meteorology, especially the observation of soil and earth temperature, and the use of which would not demand greater skill than that of the ordinary meteorological observer, led to the device and construction of the instrument to be described which may be called a "differential resistance thermometer." It consists essentially of a mercurial thermometer, not unlike ordinary forms, except that the bulb is greatly enlarged so that the stem may have a diameter of something like a millimetre, and still leave the scale tolerably "open." In one of the instruments already made 1° C. corresponds to about 5 m.m. of the scale. Running down through the stem is a fine platinum wire about 0·08 m.m. in diameter. The lower end may be secured in the bulb so that it is kept straight in the bore of the stem, and at the lower end a heavier wire is sealed in the glass so that metallic contact can be made with this wire both at the upper end and through the mercury at the lower. It is evident that the resistance between these two points will depend largely (but not entirely) on the length of the platinum wire which is above the mercury in the tube, and this will depend on the temperature to which it is exposed. When this temperature rises the resistance is decreased by an amount equal to the difference between that of the platinum wire which disappears and that of the mercury which takes its place—less the increase in the resistance of the wire and mercury due to increase of temperature.

Let l = length of platinum wire exposed at o°.

s = resistance per unit length (= length of 1°) of wire.

g = resistance per unit length (= length of 1°) of mercury.

k = temperature coefficient of platinum.

h = temperature coefficient of mercury.

R_o = total resistance at o°.

Rt = resistance (including all) at $t°$.

Then—

$$Rt = R_o - \{ s(1-kl) - g \} t - (ks - gh)t_2. \qquad (1)$$

This equation is not quite rigorous, but the approximation is very close. It is of the form—

$$Rt = R_o - Bt - Ct_2. \qquad (2)$$

The simplest and best way of dealing with it is to determine the constants of the equation (2) by a series of observations, making use of the method of least squares. From the result the resistance for any degree of temperature may be calculated, or better, a curve can be constructed from which the temperature corresponding to any resistance can easily be read.

The advantage of this method over the use of a simple resistance coil is that the change in resistance accompanying a given change in temperature is much greater, and in fact it may be made as great as one desires. As a result the telephone may be substituted for the galvanometer in the resistance measurements, thus greatly simplifying the apparatus as well as increasing the rapidity with which observations may be made; or if preferred, a much less sensitive galvanometer may be used. It also possesses the very great advantage of allowing an increase of delicacy as the range of temperature decreases. For earth temperatures this is very desirable, and it will easily be seen that thermometers of this kind can be constructed for a few degrees of range, with which, by comparatively rude processes, the measurements may be correct within a very small fraction of a degree. For use in earth temperature measurements, the thermometer will be inclosed in a strong brass tube for protection, and the connection with the point of observation made by means of a cable of heavy copper wire. The cable will of course form a part of R_o in equation (2), but as it is a constant, the substitution of one cable for another, if necessary, will affect the position and not the form of the calibration curve. Its resistance must be small, relatively, and the influence of temperature upon it may be neglected.

With this device a temperature observation may be taken in less than a minute, no time being consumed in the preparation of liquids of known temperature at the observing station as in the use of the thermo-junction or the resistance coil.

THE OPTICAL PROPERTIES OF MALIC AND TARTARIC ACIDS.

By LOUIS BELL.

Among optically active substances these two acids have long been recognised as showing remarkable and inexplicable peculiarities. Much alike in chemical character, their optical properties are in most respects identical. Both show an increase of optical activity with a rise in temperature or with a decrease of concentration; both, in strong solution or at a low temperature, show a tendency to reverse the normal direction of optical rotation, and finally, under proper conditions, both actually reverse this direction, lævo-malic acid becoming dextro-rotatory, and dextro-tartaric acid becoming lævo-rotatory. Furthermore, each exists in a form itself optically inactive, but which may be split up into two forms, crystallographically enantiomorphous, and possessing optical activities sensibly equal and opposite.

This fact was shown for tartaric acid by the classical research of Pasteur,* while Bremer† extended it to malic acid. The optical properties correspond to the crystalline form so distinctly as to make it evident that the molecular structure which produces optical activity also induces crystalline asymmetry.

Both these acids also exhibit variable and anomalous rotary dispersion; tartaric acid in a very marked degree. In all respects their optical behaviour is so nearly identical that facts established by investigation of the one will uniformly be true of the other.

To explain some of these peculiarities, and in particular to assign a cause for the reversal of the direction of rotation, a phenomenon which implies some profound physical change, the following inquiries have been instituted.

The property of twisting the plane of polarisation is almost certainly due to some condition of asymmetry, either molar or molecular. In crystals it is always associated with enantiomorphs; in liquids it must be due to asymmetrical grouping or asymmetrical configuration of the molecule itself, while in gases it is quite certain that only the latter cause can operate.

In any case a change in the direction of this twisting is a change not of degree but of kind, and must involve an altered configuration of the material system upon which the ether waves impinge. In case of liquids Le Bel‡ has shown optical activity to be associated quite

* *Ann. de Chim. et de Phys.*, (2), xxiv., 442.
† *Ber. d. Deut. Chem. Ges.*, xiii., 351.
‡ *Bull. Soc. Chim.*, xxii., 337.

constantly with the presence of an asymmetrical carbon atom.

In the consideration of malic and tartaric acids the increase of specific rotation on dilution calls for careful attention. It was first investigated by Biot in case of tartaric acid, but all that he could offer by way of explanation* was the extraordinary hypothesis that the acid impressed its optical properties on the whole mass of water with which it was mingled. In a problem essentially dynamical this sort of explanation can have but little weight, and the solution must be sought elsewhere. It is evidently connected with the reversed rotation into which it gradually passes, and this in turn must plainly be associated with some change either in the molecules themselves or in their form of aggregation. Given a number of molecules twisting the plane of polarisation in a given direction, and there are four classes of causes which could reverse that direction:—1. Change of configuration of the molecule itself. 2. Formation of a hydrate or other chemical compound. 3. Building up of crystalline forms. 4. Formation of a polymeride rotary in the opposite sense from the free molecules. It is well to discuss these possibilities in order.

1. It does not seem probable that such a change could be produced by simple dilution, unaccompanied as it is by any marked thermal effects. Further, we know that the change can be produced, as when racemic acid is prepared from dextro-tartaric, but it is by no means readily effected. To form racemic acid in the way mentioned requires heating with water in sealed tubes for many hours to a temperature of 175°.† If such treatment is required to produce a lævo-rotatory modification of dextro-tartaric acid, it is highly improbable that it could be effected by any ordinary change in temperature or by any possible amount of dilution. And if the changes in temperature which produce such a marked effect on the optical activity do so by a change of configuration,—*i. e.*, from dextro to lævo forms, tartaric acid should crystallise in right- or left-handed hemihedral forms according to temperature. But such is not the case.

2. The hypothesis of a hydrate is at least quite plausible, and seems to have been the one tacitly adopted by many investigators. Biot in his later papers seems to have been inclined to accept it. The existence of a hydrate would explain most of the facts observed, and at first sight would appear very probable, but a close examination shows that no hydrate is formed.

In the first place hydrates are uniformly produced with evolution of heat, and in the case of one of the acids in question (racemic acid) the amount of heat given out has been accurately measured by Berthelot.‡ Hence we are justified in concluding that, if the dilution which so increases the specific rotation of tartaric acid is accompanied by the formation of a hydrate, it must also be accompanied by an evolution of heat. On the contrary, diluting a concentrated solution of tartaric acid causes a slight but unmistakable fall of temperature,—the uniform sign of chemical decomposition or physical disintegration. This point was demonstrated in the following way:—A small gas-washing bottle was fitted with a very sensitive thermometer passed through the rubber stopper which closed the lateral opening at the bottom. Enough distilled water to cover the bulb of the thermometer (usually 20 c.c.) was then poured in, and the contraction in the cylinder was then closed by means of a rubber stopper fitted on the end of a glass rod. About 15 c.c. of the solution to be tested was then placed in the upper part of the vessel, and the mouth was closed by a rubber stopper slipped over the rod before mentioned. Thus tightly closed, the whole apparatus was immersed in water for some hours. Finally, without taking the vessel from the water or disturbing it in any way, the glass rod was slipped upward far enough to remove the stopper from the contraction and allow the solution to run into the water. Solutions of tartaric and malic acids of from 20 to 40 per cent were thus tested, and falls of temperature of from 0·1° to 0·2° were observed. The same is true of solutions of various salts, but the fact is none the less conclusive against the formation of hydrates of the above acids.

Again, since a hydrate is a definite chemical compound, after a hydrate was formed we should expect a condition of comparative stability to be reached, but in tartaric acid there appears to be no such definite compound completed.

Finally, the most characteristic of the optical properties of these acids—*i. e.*, reversal of the direction of rotation by change in temperature—was discovered by Biot* in amorphous solid tartaric acid, in which case, from total absence of water, the possibility of a hydrate is obviously excluded. Biot had foreseen that a solution of tartaric acid would probably become lævo-rotatory if a sufficient degree of concentration could be reached, but had sought for the complete phenomenon in vain, till he found its analogue in the behaviour of melted tartaric acid, which on cooling down passes—like the solution as it is concentrated—through decreasing rotations into a lævo-rotatory amorphous solid. I have recently succeeded in obtaining slight lævo-rotation from a concentrated solution in 95 per cent alcohol at −15°.

Biot, throughout a most careful and exhaustive series of papers covering literally hundreds of pages of the *Annales de Chimie et de Physique*, was misled by the old formula of tartaric acid, ($C_8H_8O_{10}+2H_2O$), which represented it as containing water. Consequently he makes use of this hypothetical water even to explain the properties of the melted acid. His experiments, however, were very careful and elaborate, and his papers, scattered through the third series of the *Annales*, cover most of the facts concerning rotary polarisation.

The hypothesis of a hydrate being thus excluded, the next possibility is the formation of crystal molecules. This hypothesis was suggested by Dubrunfaut, Erdman, and Bechamp,† to account for bi-rotation in milk-sugar. For several reasons, however, it is not applicable to the present case. Whatever may be the nature of the modification which reverses the rotation in malic and tartaric acids, it certainly has a rotation direction opposed to that of the free acid. But malic acid shows little tendency to crystalliise in any form whatever, and the crystals of tartaric acid correspond in optical character to the solution. Hence any structure that could fairly be called a crystal would not probably show any tendency to reverse the rotation. Further, the formation of crystals would necessitate a change in optical character more rapid than that observed, as will be shown later.

From the consideration of these facts it appears that while the observed facts can hardly be accounted for by the formation of true crystal molecules, a quite similar phenomenon—the formation of a polymeric modification—may prove to be a sufficient explanation.

Such a hypothesis, in the first place, explains and agrees with the phenomena observed. Consider the case of a solution of dextro-tartaric acid, or, since the changes are here more rapid, of lævo-malic acid. As the concentration increases or the temperature falls, let a dextro-rotatory polymeride be formed. It is evident that the first effect would be to counteract the original rotation, and there must occur precisely what does occur in the acids in question,—a lessening of the initial specific rotation by an increase in concentration or a fall in temperature.

Breaking up of this polymeride by dilution or heating would obviously reproduce the same series of phenomena in the reverse order.

(To be continued.)

* *Ann. de Chim. et de Phys.*, (3), x., 385.
† Jungfleisch, *Bull. Soc. Chim.*, (2), xix., 99.
‡ *Comptes Rendus*, lxxviii., 713.

* *Ann. de Chim. et de Phys.* (3), xxviii., 351.
† *Jahresb. f. Chem.*, 1855, 671; 1856, 639.

OBITUARY.

JAMES APJOHN, M.D., F.R.S.

WE regret to announce the death of Professor Apjohn, which took place on the 2nd inst. at his residence, South Hill, Blackrock, Dublin, at the ripe and honoured age of 91 years, having been born in 1794, in the parish of Grean, County Limerick. He was educated at the Diocesan School, Tipperary, from which he entered Trinity College, Dublin, in 1814, where he distinguished himself during his undergraduate course, amongst other honours obtaining a scholarship in 1816. He took his M.B. in 1821, but all his tastes and sympathies were with the experimental sciences, and in 1825 he was appointed Lecturer in Chemistry to the Medical School, Park Street, which school he actively co-operated in establishing in conjunction with Sir Henry Marsh, Dr. Graves, Dr. Jacob, and Mr. Cusack. Dr. Apjohn's reputation as an accomplished chemist was speedily established, so that in 1828 he was elected to the Professorship of Chemistry in the Royal College of Surgeons, Ireland, where his celebrity as a lecturer attracted students from all parts of the United Kingdom. In 1841 he was appointed by the Board of Trinity College, Dublin, Lecturer on Applied Chemistry, and in 1850, the Chair of Chemistry in the University becoming vacant, he was unanimously elected to fill it, the Professorship of Mineralogy being subsequently added. As a chemist, practical and theoretic, Dr. Apjohn has long held a foremost place. In 1853 he was unanimously elected a F.R.S. From time to time he has written numerous original memoirs on various subjects connected with chemistry and general physics. In 1837 he obtained from the Royal Irish Academy the Cunningham Gold Medal for an essay on "A New Method of Investigating the Gaseous Bodies." In 1874 he resigned the University Professorship, and a few years later he retired from all professional occupation. As years went on his well-known face was but seldom seen except by those who visited him in his own home, though he continued to enjoy uninterrupted good health till within a few weeks before his death, up to which time it may be said of him "his eye was not dim, nor his natural force abated," though he had long outlived the years allotted to man. With him has passed away one of the most upright and honourable of men, whose noble intellect for nearly a century shed lustre on the country of his birth.

CORRESPONDENCE.

PURIFICATION OF AIR.

To the Editor of the Chemical News.

SIR,—At the Royal Society, this afternoon, Dr. E. Frankland mentioned the interesting fact that air passed slowly through a 2-foot tube was found to be free from micro-organisms, though still containing (as shown by the optical test) an abundance of suspended matter. I venture to think that this difference in the behaviour of different suspended particles may be chiefly due to difference in their elasticity. The extremely fine particles suspended in air doubtless share in the rapid internal movements of that gas, and in passing through a tube the suspended particles must be repeatedly dashed against the sides. A particle of quartz or marble dust would rebound from the sides of the tube and be again suspended in the air. But how about the micro-organisms? We know that if we were to throw against a wall a handful of billiard balls and turnips, the first would return, while the turnips would lie at the foot of the wall. May it not be a similar action which keeps the inorganic dust suspended while the organic comes to rest?—I am, &c.,

R. WARINGTON.

Harpenden, June 10, 1886.

ESTIMATION OF POTASH.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. liii., p. 202, appeared a paper by Mr. Gladding, which was read at the meeting of Official Agricultural Chemists at Washington, Sept., 1885, and which refers to a method proposed by me (CHEM. NEWS, vol. xliv., p. 130) for estimating potash as platinum salt in presence of sulphuric and nitric acids. The essential feature of the method consists in washing the K_2PtCl_6 with a strong solution of NH_4Cl, which has previously been saturated with the small quantity of K_2PtCl_6 it is capable of dissolving.

I am pleased to see the method has been found by Mr. Gladding to yield very satisfactory results; when I published it, and, indeed until quite recently, I was not aware any other chemist had suggested the use of NH_4Cl for washing the precipitate. Lately, however, I noticed the following passage in your work "Select Methods of Analysis" (1st Edition), p. 13, under Separation of Potassium from Sodium.

For separating potassium from sodium in presence of sulphuric acid Finkener proposes the following:—Add hydrochloric acid to the aqueous solution to be analysed, then solution of chloride of platinum until the liquid is deep yellow. Add water sufficient, when boiling, to dissolve the double salt precipitated; evaporate to syrupy consistence, but not dry; extract and wash on a filter with a mixture of alcohol (sp. gr. 0·8) 2 volumes, ether 1 volume. Wash well with solution of chloride of ammonium; this decomposes the sulphate of sodium and allows it to be washed away. The filtrate, alcoholic extract, and washings contain the sodium. Heat the filter and its contents in a stream of hydrogen—a temperature of 240° suffices—extract the chloride of potassium with water, and weigh or titrate with silver solution.

It appears strange that Finkener, after recommending the treatment with NH_4Cl, should direct reduction of the K_2PtCl_6 in a stream of hydrogen, since this is quite unnecessary except as a control on the results arrived at by weighing the yellow salt.

In "Fresenius's Quantitative Analysis," 7th Edition, p. 409, the first and last portions of Finkener's method are given under his name; no reference whatever is made to the use of NH_4Cl.—I am, &c.,

DAVID LINDO.

Falmouth, Jamaica,
May 25, 1886.

AMERICAN MEDICINES.

To the Editor of the Chemical News.

SIR,—The sale of these in England is due to excessive advertising. A commonplace medicine is selected and receives some curious name. It then forms the basis of a little tale of fiction setting forth its fabulous virtues. These small pamphlets, thus charged with falsehood, are dropped into areas and slipped into letter-boxes. A demand for the medicine then arises. On a more limited scale various pharmaceutical preparations made in America are advertised in the medical journals, and find their way into prescriptions, to the discouragement of English Pharmacy.—I am, &c.,

CIVIS.

On Varieties of Starch.—Dr. F. W. Dafert.—The author has examined the starch of *Panicum candidum*. It produces instead of the ordinary blue a reddish brown colour with solutions of iodine.—*Biedermann's Centralbl.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 22, May 31, 1886.

Researches on the Densities of Liquefied Gases and of their Saturated Vapours.—MM. L. Cailletet and Mathias.—The methods which the authors describe are applicable to all gases whose critical point is higher than the freezing-point of mercury. In a graphic construction of densities each substance gives two curves which seem to coincide at the critical point. The author's experiments demonstrate that at the critical point the density of the liquid is equal to that of its vapour, whence follows a practical method of determining graphically the density at the critical point if the critical temperature is known. The expansion of a liquefied gas is greater than that of the gas itself.

Combustion and Formation Heats of the Solid Hydrogen Carbides.—MM. Berthelot and Vieille.—The authors have studied the most important pyrogenous carbides, naphthaline, acenaphthene, anthracene, phenanthrene, retene, diphenyl, dibenzyl, and stilbene, to which they have appended crystalline camphene. The formation-heat from the elements is negative for the polyacetylenic carbides, benzol, naphthalene, anthracene, phenanthrene, and acenaphthene. This circumstance is connected with the endothermic formation of their common generator, acetylene. The very character of these formations appears due to the fact that the acetylene and the carbides obtained by direct synthesis are produced by the union of hydrogen with gaseous carbon—an element of which carbon in its present forms represents merely the polymerised states, produced with a loss of energy.

Ammonia in Soils: Reply to MM. Berthelot and André. — Th. Schlœsing. — The author maintains his opinion that, generally speaking, ammonia passes from the air to the soil.

Influence of Magnesia in Portland Cements.—G. Lechartier. — The cements employed in certain cases which the author has examined were mixtures of Portland cement with magnesia, which behaves at first like an inert body. By slow degrees the magnesia becomes hydrated long after the cement has set, whilst it increases in bulk, producing an expansion and the consequent destruction of works the solidity of which appeared established. These destructive changes take place the more rapidly the more directly the water acts upon the cements and penetrates into their mass.

Theoretic Calculation of the Composition of Vapours, their Coefficients of Expansion, and their Evaporation-Heats. — M. Langlois. — The author's theory will be expounded in full at the meeting of the French Association at Nancy.

On the Diffusion of Heat and on Physical Isomorphism.—L. Godard. — The peculiarity observed by Melloni in rock-salt and by Magnus in sylvine belongs also to the isomorphous and anhydrous chlorides, bromides, and iodides. These bodies, which have the same chemical formula and which crystallise in the same system, possess the same physical property as regards diathermaneity, thus further confirming the analogy of physical properties presented by isomorphous bodies.

Combustion-Heats of Fatty Acids and of certain Fats thence derived.— W. Louguinine.— The author concludes from his experiments that in the combination of fatty acids with glycerin with elimination of 3 mols. of water there is an absorption of about 30,000 calories. In a word this etherification is accompanied with the same order of phenomena as the formation of the ethers of the fatty acids by means of a monatomic alcohol. It becomes easy to calculate, by means of the relation which the author has indicated, the combustion-heat, and consequently the formation-heat, of all the fats derived from the fatty acids.

Law of the Yield corresponding to the Maximum of Useful Work in an Electric Distribution.—M. Vaschy.—A mathematical paper, not susceptible of useful abridgment.

Dissociation of Calcium Carbonate.—H. le Chatelier —The tension of dissociation of calcium carbonate becomes equal to the atmospheric pressure at 812°. The normal temperature for the decomposition of calcium carbonate, in other words for burning lime, is 30° above the melting-point of silver, or 925°.

A New Gaseous Body, Phosphorus Oxyfluoride.—H. Moissan.—The new compound, PF_3O_2, has an experimental density which oscillates between 3·68 and 3·75. It is instantly absorbed by anhydrous alcohol, by solutions of chromic acid, or by the alkalies. The existence of this compound renders impossible the experiment indicated by Davy, who proposed to isolate fluorine by burning phosphorus fluoride in an atmosphere of oxygen inclosed in a vessel of fluor-spar. Fluorine has a curious property of tending always to form ternary or quaternary addition-products.

The Direct Chlorinisation of Methyl-benzoyl.—H. Gautier. — By the direct chlorinisation of methyl-benzoyl at an elevated temperature we obtain at once, and simultaneously, the three chlorinised derivatives in the chain. On pursuing the action of chlorine under the same conditions, the formation of benzoyl chloride was not observed.

Action of Hydrogen Peroxide upon Benzoic Acid in presence of Sulphuric Acid. — M. Hanriot. — The author has obtained salicylic acid, and a small quantity of an acid which he has not yet succeeded in isolating, but which approximates on the di- and tri-oxybenzoic acids. Cinnamic acid, on similar treatment, furnishes benzoic acid.

On Jaborine.—MM. Hardy and Calmels.—Jaborine, a principle obtained from pilocarpine, is deposited from ether or alcohol as a brown mass, which dries up to a brittle varnish. It is insoluble in water, but soluble in jaboric acid.

Absorption of Potassium and Calcium Bicarbonates by the Rootlets of the Beet during the Vegetation of the First Year, and the Transformation of these Salts into the Corresponding Salts of Organic Acids.—H. Leplay.—The author draws from his experiments the conclusion that the potassium and calcium contained in the soil in the state of bicarbonates are absorbed by the rootlets of the plant during vegetation, and are found again, in the roots and the leaves, in combination with organic acid formed by the reduction of carbonic acid.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 10, May 15, 1886.

Determination of Acid Magenta in Wines. — M. Sambuc. — Cazeneuve's manganese peroxide process yields results constantly below the truth, the manganese retaining in some cases three-fourths of the colouring-matter. Lead peroxide has a still more energetic retaining action. The author is endeavouring to work out a spectroscopic process.

Detection of Orange and Yellow Colours in Wines by the Use of Metallic Oxides.—P. Cazeneuve.—Coal-tar oranges and yellows are often added to wine. They may be detected by means of mercury oxide, hydrated lead peroxide, and ferric hydroxide. The author causes one and the same oxide to act successively upon the wine

in constantly increasing proportions. He commences with 10 centigrms. of the yellow mercury oxide, then 15 centigrms., and finally 20 centigrms., boiling the reagent each time with 10 c.c. of wine. For ferric oxide this precaution is unnecessary.

Observations on the Detection of Albumen by the Musculus Process.—H. Prunier.—The author finds that peptone present in urine may simulate albumen. The Musculus process should always be checked by the ebullition method, and by heating with saturated solution of sodium sulphate and acetic acid.

Determination of Urea and of Total Nitrogen in Urine: Coefficient of Utilisation of the Human Machine.—R. Huguet.—Some authors make this coefficient 0·95. M. Huguet has found cases where it did not exceed 0·60.

Poisoning by Colchicine.—The details of a chemico-legal investigation, conducted by MM. Brouardel, Pouchet, Vulpian, and Schützenberger, in a case of alleged poisoning. The results were not conclusive and the experts reported accordingly.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xv., Part 2.

Origin of the Electricity of Storms and of Ordinary Atmospheric Electricity.—L. Sohnke.—The violent movement of particles of ice and water which actually occurs in the upper regions of the atmosphere on the breaking out of a storm is accompanied with a strong electrisation of such particles.

Influence of the Soil and the Crops upon Atmospheric Moisture.—E. Wollny.—The proportion of moisture in the atmosphere depends, not only on processes taking place in the atmosphere itself but on the soil and on the vegetation, and increases or decreases with the evaporation from the latter. The influence of soils and plants upon atmospheric moisture becomes the more prominent the more extensive the surface occupied by any given kind of soil or of vegetation. The higher the capacity for water and the consequent evaporative power of a soil the greater is the proportion of moisture in the superincumbent strata of air. With reference to the chief types of soils the atmospheric moisture is *ceteris paribus* highest over humus soils, lowest over sands, and takes an intermediate position over clays. The air over flat and concave surfaces is moister than that over adjacent slopes. Ground inclining to the north contributes more to the moisture of the air than southern slopes. Easterly and westerly inclines take an intermediate position. Other things being equal the moisture of the air is greater over a tract covered with vegetation than over a bare soil. The influence of vegetation upon aërial moisture is the more prominent the more dense the vegetation, the more luxuriant the growth of the stems and leaves, and longer the time of vegetation and the moister the soil. Among ordinary crops meadows give off the most moisture to the air; then follow perennial fodder plants such as clover and lucern; then summer crops which have a prolonged vegetation, such as turnips, maize, oats, beans, and potatoes; then those of briefer growth, flax, rye, barley, and pease, and lastly winter wheat.

Microbia of the Air of Lofty Eminences.—E. de Freudenreich.—The author's observations prove the paucity of microscopic organisms in the air of localities of from 2000 to 3000 feet in height.

Natural Enemies of Rimpau's Moor-Dam Cultivation.—M. Fleischer and others.—These enemies are summarised as ferrous sulphate and free sulphuric acid, derived from iron sulphides. As a remedy the authors recommend lime whether as hydrate or carbonate, provided only that it is in a state of fine division and universally distributed. They point out, however, that barrenness sometimes arises from the accumulation in the soil of calcium sulphate, "which is found by experience to have an unfavourable action upon many crops."

Immediate Fixation of Atmospheric Nitrogen by Clay Soils.—F. and H. Marie-Davy.—A report on Prof. Berthelot's experiments on the fixation of ammonia in the soil.

Agreement among South German Experimental Stations and Manure Manufacturers on a New Basis for the Commercial Value of Superphosphates and Precipitated Phosphates.—Prof. P. Wagner.—Already noticed.

Manurial Experiments on Elevated Moor-lands Exhausted by Repeated Burning.—M. Fleischer and others.—The elevated moor-lands of North-western Germany are burnt every autumn and then planted with buck-wheat for a period of six years. At the end of this time they are exhausted and have to lie waste for twenty to thirty years until sufficient humus has accumulated for a repetition of the burning process. The authors have experimented on methods for abridging this period of barrenness.

Inspection and Adulteration of Manures.—Prof. E. von Wolff, Prof. Wagner, and Dr. Müller.—It appears that Freiburg poudrette containing 3·5 nitrogen, 5·9 phosphoric acid, and 2·2 per cent potash, is sold at six marks per cwt. Near Hildesheim itinerant manure-makers offer to make a cheap and efficient manure in the consumer's own yard. Garden soil is mixed with quicklime and night-soil. The next day it is turned over and sulphuric acid is poured into a hole in the middle of the heap. The whole is mixed up, some sulphate of ammonia and bone-meal are added, turned over several times, and the manure is complete. The maker receives one mark per cwt., and the finished product contains possibly 1·92 nitrogen and 1·11 phosphoric acid. It costs the farmer about 5s. 6d. per cwt.

Method for observing the Assimilation and Respiration of Plants and on certain Circumstances which determine these Processes.—Prof. U. Kreussler.—This voluminous memoir does not admit of useful abstraction.

Experiments in Electric Cultivation.—Braune and Maercker.—Experiments were made with seven rows of beets, the two outer rows to the left and right were treated with electric currents, whilst the three inner rows remained neutral. There was a decided gain in the gross weight of the produce, and a smaller gain in the proportion of sugar.

Die Chemische Industrie.
Vol. ix., No. 4, April, 1886.

Toxicological Laboratory of the City of Paris.—This establishment receives a yearly subvention of 18,800 francs. The personal comprises a sub-director, a chemical and a physiological assistant. The labours of the laboratory comprise the study of the chemical and physiological properties of poisonous substances; the theoretical and practical study of the methods of detecting poisons, with reference to possible errors; microscopic, physiological, and anatomic pathological studies of the various questions of forensic medicine. The laboratory is in connection with the medical faculty.

Disadvantages of a Badly-arranged Glover's Tower in the Manufacture of Sulphuric Acid.—Hugo Borntträger.—The author describes a tower filled with broken quartz rock. The draught being very bad the tower required washing out every four or eight weeks. The yield in the second year, when the tower required washing out every three weeks, was so bad that for 100 parts of sulphuric acid at 50° (? B.) there were consumed 65·74 parts pyrites and 2·19 parts nitric acid at 36°. The burnt ore showed 11 per cent of sulphur. The draught in

the Glover tower is therefore of primary importance for the manufacture of sulphuric acid. The author recommends that the height of the pyrites above the grate in the kilns should be at least 70 c.m. Behind the kilns there should be a short annex of masonry in which the sublimed zinc oxide may be deposited, to which is then joined a short flue of one metre in diameter leading to the Glover tower. The tower should be filled with tiles, cylinders, &c., of baked fire-clay. On the draught depend the thorough utilisation of the pyrites, and especially the consumption of nitric acid. After leaving the chambers the gaseous mixture should pass not through one, but three or four Gay-Lussacs, fed with acid at 62° (B ?) cooled down to 5°.

Use of Congo Red in the Titration of Aniline.—Dr. P. Julius.—The azo-dye known in commerce as "Congo red," and formed by the combination of tetra-azo-diphenyl with naphthol-sulphonic acids dissolves in alcohol and in water with a red colour, which is turned to a blue by acids but re-produced by alkalies. The sensitiveness of Congo red is such that a slip of paper, stained with this dye and then turned blue by an acid is rendered red again by exposure to tobacco smoke. This great sensitiveness of Congo red renders it a useful indicator with which aniline and its homologues can be quickly volumetrically determined. The limit of error is only 0·2 per cent on either side, hence this method is well adapted for the determination of aniline and toluidine in the waste waters and echappés of the manufacture of coal-tar colours. The determination is effected in the ordinary manner, diluting with water until everything is dissolved, adding a little of the alcoholic solution of the indicator, and titrating with normal sulphuric acid until the red colour of the solution passes into a violet with a decided blue cast. With a little practice this point may easily be recognised, as a slight further addition of acid produces no change in the colour. A pure blue is produced only by a relatively considerable excess of acid.

Crystalline Silico-carbonate from Soda-lyes.—C. Rammelsberg.—On a former occasion the author has described crystals of artificial Gay-lussite, a sodium-calcium carbonate containing 5 mols. of water. Latterly he has received from Dr. Reidemeister, of the Schœnebeck Alkali-Works, crystals consisting of the silico-carbonates of sodium, calcium, and aluminium. Aluminium-sodium silicates have also been obtained free from calcium.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 4, April, 1886.

This issue contains no chemical matter.

Archives Neerlandaises des Sciences Exactes et Naturelles. Vol. xx., Part 4.

This issue contains no chemical matter.

MISCELLANEOUS.

A New Agent for Thickening Mineral Lubricating Oils.—Dr. L. Marquardt.—The new agent employed is aluminium oleate, a solution of which in mineral oils is sold as "liquid gelatin," though it contains not a trace of gelatin. This adulterating agent during use separates out from mineral oil, especially if it comes in contact with water. If the sophisticated oil is heated it foams violently, as it also happens when it is mixed with mineral oil for use. If it is shaken up with alcohol at 95 per cent, and ether is gradually dropped in, there comes a moment when the oleate of alumina separates out, first in flocks, and then in clots. The aluminium oleate can be recognised, on the one hand, by separating the fatty acids with dilute hydrochloric acid and saponifying with soda-lye, and, on the other, by determining the ash. In pure mineral oils the ash does not exceed 0·058 per cent.—*Zeitschr. f. Anal. Chemie*, vol. xxv., part 2.

Royal Society.—At the Soirée of the Royal Society at Burlington House, on June 9th, the following list of objects were exhibited by Mr. William Crookes, F.R.S., V.P.C.S., illustrating the Existence of New Elements in Gadolinite and Samarskite:—

Minerals containing Rare Earths.

Euxenite.—A columbo-tantalate, containing titanic acid, yttria, and uranium. About 28 per cent of yttria.

Fluocerite.—A fluoride of cerium, containing also didymium and yttrium.

Gadolinite.—A silicate of cerium, yttrium, and iron. About 48 per cent of yttria.

Hielmite.—A stanno-tantalate of iron, uranium, and yttrium. About 5 per cent of yttria.

Monazite.—A phosphate of cerium, lanthanum, didymium, and thorium.

Orangeite.— } A silicate of thorium. About 70 per cent
Thorite.— } of thoria.

Samarskite.—A urano-tantalate, containing tungsten, iron, and earths of the cerium and yttrium groups. About 10 per cent of yttria.

Earths and Salts prepared from the above Minerals.

Ceria. Ceric oxalate. Decipia. Didymia. Didymic oxalate. Didymic sulphate. Erbia (rose-coloured). Gadolinia (Yα). Lanthana. Lanthanic oxalate. Thulia (with Erbia). Niobic acid. Philippic (?) formate. Samaria. Tantalic acid. Terbia. Thoria. Thoric oxalate. Thoric sulphate. Ytterbia. Yttria. Zirconia.

Coloured Spectra, Diagrams, and Radiant Matter Tubes illustrating the Existence of New Elements in Gadolinite and Samarskite.

The following table gives the mean wave-length of certain definite absorption-bands or lines in the phosphorescent spectra of presumably new elements which have been separated from the above minerals by fractional precipitations, repeated many thousand times:—

Position of lines in the spectrum.	Scale of spectroscope.	Mean wave-length of line or band.	$\frac{1}{\lambda^2}$	Provisional name.	Probability.
Absorption bands in violet and blue..	8·270°	443	5096	Dα	New.
	8·828	475	4432	Sβ	New.
Bright lines in—					
Violet	8·515	456	4809	Sγ	Ytterbium.
Deep blue	8·931	482	4304	Gα	New.
Greenish blue (mean of a close pair)	9·650	545	3367	Gβ	Gadolinium.
Green	9·812	564	3144	Gγ	New.
Citron	9·890	574	3035	Gδ	New.
Yellow	10·050	597	2806	Gε	New.
Orange	10·129	609	2693	Sδ	New.
Red..	10·185	619	2611	Gζ	New.
Deep red	10·338	647	2389	Gη	New.

A large induction-coil, containing about 60 miles of secondary wire, and capable of giving a 24-inch spark, used to illustrate the Radiant Matter method of spectrum analysis. New form of tube for spark spectra, avoiding loss by splashing or evaporation. Large spectroscope of new construction, showing spark spectra of some of the rare earths.

City and Guilds of London Institute.—We wish to call the particular attention of students to the eleven courses of lectures in connection with this Institute, to be delivered next month at the Central Institution in Exhibition Road. To chemists and physicists the most interesting of these courses will be those by Professor Armstrong, F.R.S., on "The Teaching of Chemistry as introductory to its Technical Applications"; by Prof. W. E. Ayrton, on "Experimental Physics as a Subject of Instruction in Technical Schools"; on "Candle Manufacture and the Treatment of the By-products," by L. Field, F.R.S.E.; and on the "Chemistry of Tanning," by H. R. Procter, F.C.S., and on the "Technology of Cellulose and Paper Manufacture," by C. F. Cross and E. T. Bevan. This course, though mainly intended for paper manufacturers, will be of value to all persons concerned in bleaching, dyeing, or printing vegetable fibres. For particulars of fees, time, &c., we must refer to the announcements which have lately appeared in our advertising columns.

Determination of Arsenic in Iron.—E. Lundin.—The author dissolves 6 grms. of the specimen in 70 c.c. of nitric acid (sp. gr. 1·2), mixes the solution with 40—45 c.c. sulphuric acid, and evaporates with frequent stirring until the nitric acid is entirely expelled, heating towards the last so strongly that a part of the sulphuric acid is driven off and no more bubbles appear in the mass. The residue is mixed with 8—12 grms. ferrous sulphate in a flask holding 300 c.c. and distilled with 70 c.c. hydrochloric acid (sp. gr. 1·19). The distillate is received in 300 c.c. of hot water and treated further in the known manner.—*Zeitschr. f. Anal. Chemie*, vol. xxv., part 2.

The Titration of Soda in Presence of Alumina, Vanadium, and Tungstic Acid.—E. B.—A soda containing aluminate will, on titration with acid and dimethyl-orange, show too much sodium carbonate if the operator proceeds gradually until a permanent red is obtained, in the proportion of 53 soda for 17 of alumina. Suppose that a somewhat impure Leblanc soda contains 1 per cent of matter insoluble in water, of which the half is alumina, there might be found 1½ per cent of soda in excess, if the insoluble matter is not previously removed, which mostly takes place. Vanadiferous sodium carbonate, if similarly treated, gives a brown colour, the red tint appearing only after a considerable excess of soda has been added. Litmus-paper must here be used. Tungstic acid has a similar action, but such sodas rarely occur in commerce. —*Zeitschr. f. Anal. Chemie*, vol. xxv., part 2.

Determination of Silicon in Iron.—L. Blum.—The author covers 5 grms. crude iron in an Erlenmeyer boiling flask or an evaporating dish with 100 c.c. of water and 150 c.c. bromised hydrochloric acid. Heat is evolved and the iron dissolves in a few moments. The liquid is then boiled to expel the excess of bromine, the liquid is mixed with the solution of 10 grms. ammonium chloride, and evaporated on the water-bath to complete dryness. The residue is taken up in strong hydrochloric acid, diluted, and filtered. The undissolved portion remaining on the filter is washed first with water, then once with bromised hydrochloric acid, twice with hot water, once again with bromised hydrochloric acid, and finally with hot water. The precipitate, still moist, is placed along with the filter in a platinum boat and ignited in the muffle until the graphite is entirely burnt away.—*Chemiker Zeitung.*

The Precipitability of Iron by Sulphuretted Hydrogen.—L. Storch.—If a solution of stannic chloride and of ammonium-stannic double chloride is mixed with an excess of an iron salt and a current of sulphuretted hydrogen is introduced, the precipitate has not the pure yellow colour of stannic sulphide, but varies from dirty yellow to greyish-green. The latter colour occurs if a solution of the double chloride is taken, a solution of ferrous or ferric chloride containing a minimum of hydrochloric acid is added in excess, and the whole is poured into an excess of sulphuretted hydrogen water. If the precipitation is effected by the gradual addition of sulphuretted hydrogen water, it is distinctly observed that the precipitate is at first pure yellow, until all the tin is thrown down; but the longer the addition of the precipitate is continued the dirtier becomes the colour of the deposit. It darkens a little afterwards on standing, more rapidly if heated. Larger quantities of hydrochloric acid are necessary to prevent the precipitation of iron, but then there is danger that all the tin may not be thrown down.—*Ber. Chem. Gesellsch.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sulphuric Acid.—I am desirous of learning the titles and prices of a few books on sulphuric acid and vitriol making.—W. M.

Sulphuric Acid.—Will some reader give particulars of a work on the manufacture of sulphuric acid from the spent oxide of gas works? —Onward.

MEETINGS FOR THE WEEK.

Wednesday, 23rd.—Geological, 8.
Friday, 25th.—Quekett, 8.
Saturday, 26th.—Physical, 3. "On Certain Sources of Error in connection with Experiments on Torsional Vibrations," by Herbert Tomlinson.

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2. On Candle Manufacture and the Treatment of the By-Products. Four Lectures by Leopold Field, F.R.S.E., on July 5th, 6th, 8th, and 9th, at 7.30 p.m. each day. Fee 5s.

3. On the Chemistry of Tanning. Four Lectures, with experimental illustrations, by Henry R. Procter, F.C.S., on July 12th, 13th, 15th, and 16th, at 7.30 p.m. Fee 5s.

4. On the Technology of Cellulose and Paper Manufacture. Four Lectures by C. F. Cross, Esq., F.C.S., assisted by E. T. Bevan, Esq., F.C.S., on July 19th, 20th, 22nd, and 23rd, at 7.30 p.m. Fee 5s.

5. On Building Materials. Four Lectures by W. G. Dent, F.C.S., F.I.C., on July 26th, 27th, 29th, and 30th, at 7.30 p.m. Fee 5s.

Further particulars and Syllabus of each Course may be obtained at the Central Institution, Exhibition Road, S.W., or at Gresham College, London, E.C.

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THE CHEMICAL NEWS.

Vol. LIII. No. 1387.

IODALDEHYDE.

By W. POPPLEWELL BLOXAM, Royal Naval Coll., Greenwich, and E. F. HERROUN, King's College, London.

The authors, wishing to determine the composition of the oils obtained by Aimé (*Ann. Chim. Phys.*, lxiv., 217) and Johnston (*Phil. Mag.* [3], ii., 415) by the treatment of alcohol with iodine and strong nitric acid, proceeded using iodine mixed with four times its weight of alcohol, an equal volume of strong nitric acid being added. A heavy yellowish oil separated after several days had elapsed, and, on distillation, yielded a variety of products, ethyl nitrite, ethyl nitrate, and traces of a cyanogen compound. On reaching 80° the oil became dark coloured, evolved iodine, and evidently decomposed.

On comparing the work of Aimé and Johnston it was noticed that the boiling-point (Aimé) was given as between 25° and 115°, whilst Johnston records it as 110°.

Aimé obtained iodoform by treatment of the oil with potassic hydrate; Johnston makes no mention of iodoform obtained by like treatment. The latter regarded the oil as iodic ether.

Watts (vol. iii., p. 280) describes a third and solid substance obtained by Schonbroodt (*Bull. Soc. Chim. de Paris*, 1861, p. 109) under the head of iodal.

At the time of experiment a paper was communicated to the Academie des Sciences (published, *Comptes Rend.*, No. 2, 1886, Jan. 11) by P. Chautard entitled "Iodaldehyde." The properties attributed by Chautard to iodaldehyde were similar in many respects to those of the oil obtained in the manner previously stated. Since the products of the action of alcohol, iodine, and nitric acid were, as would be expected, highly complex, it was considered advisable to acquaint ourselves with the preparation and properties of the moniodaldehyde of Chautard.

Following with care the directions given we have made numerous attempts to prepare the body, failing altogether to isolate it in the manner described, although qualitative evidence of its presence was obtained.

The method given by Chautard is as follows:—Introduce into a matras of 2 litres capacity 50 grms. of iodine, 20 grms. of crystalline iodic acid, and 150 c.c. of an aqueous solution of aldehyde (30 per cent). There is no disengagement of heat. The matras is closed and left at the ordinary temperature of a room. Streaks are formed as the iodine dissolves. After a variable time, which does not exceed three or four days in summer and eight in winter, the iodine has completely disappeared and the operation is finished. Usually no separation takes place, as the iodaldehyde dissolves in the excess of aldehyde present. On addition, however, of about half a litre of water separation of the oil takes place—the yield is theoretical. Any dissolved iodine is removed by agitating the oil with perfectly pure mercury and ether.

The proportions of Chautard being inconveniently large fractional quantities were taken for experiment. The solutions of aldehyde used were obtained from various sources, some being prepared with care from aldehyde-ammonia, and dilute sulphuric acid, the distillate being made up to the required percentage with water; others obtained by the action of MnO_2 and H_2SO_4 on alcohol; the remainder from aldehyde purchased.

The streakiness described by Chautard was observed in all cases, but the time required for the complete solution of the iodine was always much longer than that stated, extending in some cases over several weeks. The product possessed invariably an extremely pungent odour, was of a very dark colour, and failed on treatment with water to yield any permanent oil.

In two or three cases traces of a black oil were obtained on treatment with water, which, however, rapidly disappeared.

It was observed that the purest specimens of aldehyde—in strong or weak solution—dissolved iodine to an extremely limited extent, even on prolonged contact at the temperature of the laboratory.

These observations do not accord with Chautard's statement that iodaldehyde is obtained by the direct action of iodine on aldehyde (no condition of temperature being given), and in large quantities with the greatest ease ("avec la plus grand facilité") when iodic acid is present.

Although we failed to obtain a single specimen of iodaldehyde by Chautard's method, still the qualitative indications agreed in many respects with the properties of the product obtained repeatedly by us whilst operating with nitric acid and iodine on alcohol. The first step taken to diminish the complexity of the products was by using a much smaller quantity of nitric acid than in Aimé's experiments.

On dissolving iodine in alcohol (85 per cent), adding a small quantity of strong HNO_3 and maintaining at a gentle heat (40°) the solution decolourises, and iodine is rapidly taken up. The vapours evolved are of the character ascribed by Chautard to iodaldehyde, irritating the eyes and air passages to an almost unendurable extent, inhalation being invariably followed by headache and discomfort, extending often over two or three days. On distilling—the temperature being kept carefully below 80°—the more volatile portions distilled over, and the residue, on treatment with water, yielded a heavy oil of pale yellow colour, possessing the irritating properties to an intense degree.

The oil was soluble in water to some extent, communicating to it its odour.

It was subsequently found that aldehyde might be substituted for alcohol, with advantage to the preparation, yielding apparently the same body. When aldehyde is used a few drops of nitric acid suffice to start the action when gently warmed.

Qualitative examination of the oil gave the following results:—

Readily soluble in alcohol, ether, and benzol.

On warming the oil in a test-tube it partly distilled and rapidly decomposed with liberation of iodine.

Aqueous sodic hydrate instantly produced iodoform in large quantity, at the same time completely destroying the pungent smell.

Sodic carbonate yielded a similar result, and even barium carbonate decomposed aqueous solutions of the oil.

Aqueous solution of argentic nitrate yielded a nearly white precipitate, becoming yellow and rapidly increasing in amount on warming. On examination the precipitate was found to consist of silver iodide. Dilute acids (H_2SO_4, HNO_3, HCl) were found to act on it but slowly at ordinary temperatures—in which respect it appears to differ considerably from Chautard's product, which he describes as being broken up instantly by even dilute acids.

Owing to the great difficulty of purifying the oil from the other products of the reaction, at present our attempts to isolate it in a sufficiently pure condition to determine its composition have been only partially successful, but in view of the similarity of its origin, and close agreement in many of its properties, with the mon-iodaldehyde of Chautard, we have thought it well to publish the present note in the hope that some, who may have tried Chautard's preparation with better success than ourselves, will be induced to contribute information which will enable us to compare the two bodies under more favourable conditions.

We should at the same time be glad to learn from M.

Chautard or others the equation in accordance with which the transformation of mon-iodaldehyde, C_2H_3IO, into iodoform takes place; and whether the by-products actually produced have been found to agree with this equation.

ESTIMATION OF ARSENIC IN ORES, MATTES, AND METALLIC COPPER*.

By G. W. LEHMANN and W. MAGER.

In the course of professional work at our laboratory it has become necessary to determine small quantities of arsenic, and after testing the methods proposed for this purpose, we have found that proposed by R. Pearce† to be the most reliable and convenient. This consists in mixing the finely powdered substance with about six times its weight of equal parts of sodium carbonate and potassium nitrate, fusing and extracting with hot water, and filtering. The filtrate is then acidified with nitric acid and boiled to expel carbonic and nitrous acids. To the cool solution silver nitrate is added, and then ammonia to neutral reaction. The silver arsenate is filtered, washed out with cold water until no silver is found in the washings, and the silver determined by Volhard's method. 108 parts of silver correspond to 25 parts of arsenic. Numerous experiments with ores and mattes (free of arsenic) mixed with known quantities of chemically pure arsenious oxide, and containing lead, antimony, and aluminium salts (purposely added), convinced us of the accuracy of the method. Now the question arose how this method could be best applied to metallic copper containing about one-tenth per cent of arsenic.

We found it most convenient to precipitate the arsenic in combination with oxide of iron. Considering that metallic copper very rarely is free from arsenic, and that borings taken from different parts of the same ingot contain different quantities of arsenic, we dissolved in each case 100 grms. of copper in nitric acid, diluted to 500 c.c. with water, and took 100 c.c. (20 grms.) for each determination.

In the first 100 c.c. we determined the arsenic contained in the copper; to the second and third 100 c.c. we added known quantities of arsenic which had been prepared by fusing chemically pure arsenious oxide with sodium carbonate and potassium nitrate and dissolved in nitric acid, and deducted the first result from the last. We proceeded in the following way:—A piece of iron sulphate, about the size of a pea, was dissolved in nitric acid, added to the copper solution, and then ammonia in excess; the solution was well stirred and the precipitate of oxide of iron filtered hot, washed out with hot water, dried, removed carefully from the filter, mixed with the fusing mixture, &c. In another series of experiments we added lead and antimony, and found that their presence did not interfere with the results. (A solution containing both metals in considerable quantity gave 0·131 per cent and 0·144 per cent arsenic, when 0·134 per cent arsenic was present.)

The following results show the accuracy of the method:—

As present.	As found.	
0·0701 per cent.	0·0615 per cent.	0·0596 per cent.
2·87 ,,	2·82 ,,	2·94 ,,

0·0118 grm. As_2O_3 (used in these experiments) gave 0·00907 grm. As. Calculated 0·00894 grm. As.

As present Per cent.	As found. Per cent.	
0·01	0·1004	$AsMg(NH_4)AsO_4 = 0·092$ per cent.
	0·0953	

* From the *American Chemical Journal*, Vol. vii., No. 2.
† See *Engineering and Mining Journal*, May 5th, 1883, p. 256.

METHOD FOR DETERMININING FUSEL OIL IN ALCOHOL, ESPECIALLY IN BRANDIES AND LIQUEURS.*

By Dr. J. TRAUBE.

The attention which has recently been drawn to the examination of brandies induced the author to investigate the most important methods which have been proposed for determining their proportion of fusel. The result was that those methods which have been regarded as most trustworthy, and which seem to be most frequently employed, must be pronounced almost worthless.

Such are the two colorimetric methods; the one depending on the reddening or browning of brandies when heated with strong sulphuric acid, the other founded on the reddening produced by the addition of aniline and hydrochloric acid.

Although attention has already been drawn to the untrustworthiness of these methods they still play a great part in the examination of brandies. The first-mentioned reaction is supposed to be especially due to isoamylic alcohol, as such, whilst the latter is ascribed—probably with justice—to the furfurol supposed to be present in most fusel oils.

As to the sulphuric acid reaction it at once appeared in the author's experiments that alcoholic solutions of crude fusel oil, heated under identical conditions with equal parts of sulphuric acid, became more deeply coloured than corresponding solutions of pure amylic alcohol, and that brandies containing a proportion of fusel oil demonstrably much smaller than the above solutions were coloured as deeply as solutions containing 2 to 3 per cent of fusel oil. The supposition that the colouring by means of sulphuric acid was especially due to the ready decomposition of small quantities of substances boiling at high temperatures, present in the fusel oils, such as furfurol, &c., was confirmed by experiment. It was observed that 1 part of furfurol dissolved in 25,000 parts of alcohol produced a deeper colour than 1 per cent of amylic alcohol.

The furfurol-reaction depending on the reddening by aniline and hydrochloric acid, is no better than the sulphuric acid process. In order to draw conclusions as to the proportion of fusel from the intensity of the colouring, it was assumed that the quantities of furfurol were approximately proportioned to the quantities of fusel oil. But that this by no means the case was shown by experiments made with 2 per cent solutions of various crude fusel oils in alcohol. In the solution of a potato-fusel, obtained from Marquard, of Bonn, and of a maize-fusel procured from Kahlbaum, there was a distinct reddening. In solutions of crude corn (probably rye) and treacle (doubtless beet-root treacle), fusel obtained from the same firm, the reddening was scarcely perceptible. Independently of these experiments, the furfurol reaction was found to be so intense that it scarcely allowed of inferences as to the proportion of fusel present. It was observed that 1 part of furfurol could be detected in 3 million parts of alcohol, and that even the strongest colouration which was observed in a large number of samples of brandy would at the most indicate the presence of one part furfurol in 100,000 parts. But with such traces of furfurol no one could undertake to decide how many tenths of a per cent of fusel are contained in brandy.

Of the methods hitherto proposed for determining fusel that of Röse only requires notice. It is based upon the fact that on shaking 50 per cent alcohol with chloroform the liquid increases in volume, so much the more the richer the alcohol is in fusel. But this method has also its defects, and appears to be both more tedious in execution and less capable of accuracy than the capillarimetric method about to be described, which permits rapidly and

* Reprint from the *Zeitschrift für Spiritus Industrie*, 1886, No. 36.

easily the detection of fusel in brandies down to about $\frac{1}{20}$ per cent.

The fact demonstrated by the author in various chemico-physical researches that the height to which aqueous solutions of organic bodies of one and the same series ascend in capillary tubes (the percentage remaining the same) often decreases very considerably with an increasing molecular weight of the dissolved body, rendered it probable that even a very small percentage of fusel in brandies would betray itself by a reduction of the capillary ascent. It was known to the author from previous researches that the substances present in fusel in estimable proportions, such as the propylic and butyric alcohols, and the various aldehydes, including furfurol, reduced the capillary ascent more than ethyhic alcohol, but less than amylic alcohol. It was to be expected that any differences in the composition of the fusels or of the brandies would have only a vanishing influence upon this method, —an assumption which has been fully confirmed by experience.

As regards the observation of the height of ascent, and the apparatus employed, the author refers to his paper in the *Journal für prakt. Chemie* (New Series, vol. xxxi. pp. 177, 178). He remarks here only that a thin-sided capillary tube, as narrow as possible, is fastened to a very fine scale, divided into half millimetres. The scale terminates at its zero in two points, which are set exactly at the surface of the liquid by means of a stand movable upon screws. The capillary tube can easily be kept clean if it is washed after every experiment with water and alcohol, and afterwards dried by forcing through it a current of air dried and purified over sulphuric acid. The liquid is sucked up in the capillary tube two or three times, and the bottom of the meniscus is read off a few seconds after the liquid has come to rest. With a little practice and the observation of all precautions it becomes readily possible to read off to $\frac{1}{10}$ m.m. even without a lens.

With this apparatus the author has examined a number of solutions containing from 0·1 to 1 per cent (by volume) both of crude fusel and of pure isoamylic alcohol dissolved in an alcohol, the specific gravity of which always corresponded to that of a 20 per cent by volume. This is a degree of concentration very suitable for the examination of brandies. In the table below the capillary heights are given in millimetres. Each observation was repeated, mostly after the tubes had been previously dried.

From this table it appears that the solutions of pure isoamylic alcohol, according to expectation, show a rather lower capillary ascent than the corresponding solutions of the crude fusel oils.

It appears that generally $\frac{n-1}{10}$ per cent of amylic alcohol corresponds to $\frac{n}{10}$ per cent of crude fusel. If the proportion of fusel, as in most cases, is less than $\frac{1}{10}$ per cent, it becomes possible, by reading off to $\frac{1}{10}$ m.m., to determine $\frac{1}{50}$, or, in very dilute alcoholic solutions, even $\frac{1}{100}$ per cent of fusel. The values above 0·5 per cent fluctuate slightly for the different solutions of fusel; but these values are of no practical importance, since a brandy which contains more than about 3 per cent of fusel is regarded as dangerous to health.

In the examination of brandies by the above method, a preliminary distillation is only required when—as in the case of liqueurs—the specific gravity of the distillate differs essentially from that of the original liquid. The specific gravity is then determined by means of a Mohr's balance, and the brandy is let down to 20 per cent (volume) by the aid of a dilution table. The capillary height, compared with that of pure 20 per cent ethylic alcohol, shows at once the proportion of fusel in the diluted brandy on a scale which is empirically constructed.

An error in the determination of the specific gravity, even if corresponding to $\frac{1}{2}$ per cent of alcohol, would scarcely deserve consideration, as the capillary height of alcohols at 20 and 20·5 per cent differs only by about 0·44 m.m., a depression which only represents $\frac{1}{20}$ per cent of fusel.

The determination by means of the balance is therefore sufficient. An accurate dilution to 20 per cent (volume) is the less essential, as for alcohols of 18 to 22 per cent the depressions of the capillary rise are the same as for alcohol of 20 per cent. Consequently, in an empirical scale drawn up for the latter strength, it is merely necessary to add 0·9 m.m. for every 1 per cent of alcohol.

The differences of temperature likewise involve only a very trifling correction.

The advantage of this capillarimetric method over that of Röse lies, first, in the more speedy execution of the experiments. In the author's method a preliminary distillation of the brandy may be dispensed with in most cases, and the dilution of the spirit to a certain specific gravity does not require to be carried out with such exactitude as in Röse's method. The preservation of a given temperature in producing the mixture, as this takes place in Röse's method, is tedious. Moreover, the difference in the composition of the fusels has a greater influence in Röse's method than in the author's, so that Röse has had to construct different tables for different kinds of spirits. Above all, Röse's method scarcely allows the accurate determination of less than 0·1 per cent of fusel. This point seems of great importance, as, according to the author's examinations of very impure brandies, the proportion of 0·1 per cent of fusel is seldom exceeded. Hence it appears that, if such impure brandies are condemned as unwholesome, the boundary of unwholesomeness must be fixed lower than 0·3 per cent. Of twelve brandies examined by the author, apparently very impure, only two or three contained more than 0·1 per cent of fusel, whilst the strong furfurol and sulphuric acid reactions might easily have given rise to errors.

The firm of C. Gerhardt, glass manufacturers, of Bonn, supply capillarometers tested by the author, and showing directly for different temperatures the proportion of fusel in brandies diluted to 20 per cent. The necessary corrections are shown on an accompanying table of dilutions. By means of this apparatus it is easily practicable to effect a complete examination of brandy within a few minutes.

Hannover: Bodländer and Traube's Analytical Laboratory.

Percentage of fusel in a 20 p.c. (vol.) of alcohol.	Potato-Fusel (Marquard).		Maize-Fusel (Kahlbaum).		Treacle-Fusel (Kahlbaum).		Rye-Fusel (Kahlbaum).		Pure iso-amylic alcohol.	
0	50·0	50·0	50·0	50·0	50·0	50·0	50·0	50·0	50·0	50·0
0·1	49·2	49·25	49·1	49·1	49·0	49·0	49·0	49·0	48·6	48·65
0·2	48·25	48·25	48·05	48·05	48·0	48·0	48·0	48·0	47·5	47·5
0·3	47·5	47·55	47·5	47·5	47·45	47·5	47·45	47·4	46·9	46·95
0·4	47·1	47·05	46·95	46·9	46·9	46·9	46·85	46·9	46·3	46·4
0·5	46·6	46·6	46·45	46·4	46·3	46·25	46·35	46·4	45·9	45·85
0·6	46·2	46·2	45·85	45·85	45·8	45·85	45·8	45·7	45·2	45·2
0·7	45·5	45·5	45·1	45·1	45·0	45·0	44·9	44·9	44·3	44·35
0·8	44·9	44·85	44·15	45·25	44·2	44·25	44·0	43·9	43·45	43·4
0·9	44·3	44·3	43·6	43·55	43·6	43·6	43·4	43·4	42·4	42·1
1	43·95	43·9	43·0	43·0	43·05	43·05	42·6	42·6	41·7	41·75

ON "EXPLOSIVE ICE."

By J. W. MALLET, University of Virginia.

DURING the very cold weather of the week January 8th to 15th, a French "*gazogène*," or portable apparatus for preparing carbonic-acid water under pressure, was destroyed in the laboratory of the University of Virginia, by the freezing of the contents of the upper globe, which was almost completely full of distilled water charged with carbonic acid, and was burst by the expansion of the ice formed. The globe, which was surrounded by basket-work of split cane, was of heavy glass, about 8 m.m. in thickness, and must have burst with some violence, judging from the distance to which the disc-like top was thrown. Having removed the apparatus to a warm room, in which thawing might take place without the liquid running about on the shelves and floor of the apparatus room, I had my attention attracted in a few minutes by little crackling explosions coming from the ice, which, when brought in, was quite solid and dry—much below the melting-point. Standing near and somewhat above the level of the apparatus, which had been placed in one of the laboratory sinks, I was two or three times struck in the face by little bits of ice as large as hazel-nuts, thrown off with some force from the bulk of the frozen mass. One piece, fully as large as a walnut, was thrown off to a distance of seven or eight feet upon the floor. Some of the crackling sounds fairly merited the name of explosions. Once or twice the sound was quite as loud as that produced by suddenly treading upon a friction-match.

The ice was in the main white and translucent, but with many small, glassy streaks of complete transparency running through it. It obviously contained a multitude of pretty uniformly distributed, minute bubbles of carbon-dioxide gas under heavy pressure—pressure not due merely to the space within which the gas had been originally generated, but greatly increased by the expansion of the water in the act of freezing as the gas separated out from it. It is, perhaps, not impossible that, at the existing temperature, this pressure may have even sufficed to liquefy some of the gas of the bubbles caught in the interior of the ice. The immediate cause of the explosive splitting up of the ice under the tension of the included carbon dioxide seemed to be the weakening of the former by expansion in the comparatively warm atmosphere of the room: there was but little melting during the time, some three-quarters of an hour, during which the crackling sounds and the flying to pieces of the ice lasted. A little explosion could easily be induced by striking a very slight blow with a little blowpipe hammer, or with a chisel or other sharp-pointed tool, on almost any part of the ice which had not before been so treated, and on breaking off some large pieces of the ice and placing them on the table, detached from the rest of the mass, they continued to split and fly to pieces in a very remarkable way.

The whole of the phenomena reproduced exactly the behaviour of the quartz from Branchville in Connecticut, in which occur numerous microscopic cavities containing partly liquefied carbon dioxide; but in the case now described, the explosive splitting up by heating was produced at a much lower point on the thermometric scale. —*American Chemical Journal*, vol. vii., No. 6.

Piliganine, the Alkaloid of a Brazilian Lycopod.—M. Adrian.—Piliganine, a highly poisonous principle, is soluble in water, alcohol, and chloroform, but sparingly soluble in ether. It gives, with sodium phosphomolybdate, a yellowish white precipitate; a pale brown with iodised potassium iodide; a white precipitate with tannin; a very copious white clotty precipitate with potassium mercury iodide; with picric acid, after some time, a yellowish crystalline precipitate; with mercuric chloride and platinum chloride no reaction.—*Comptes Rendus.*

THE OPTICAL PROPERTIES OF MALIC AND TARTARIC ACIDS.

By LOUIS BELL.

(Concluded from page 295).

DISSOCIATION has been suggested as a possible cause of analogous optical properties by Oudemans,* but he refers it to the breaking up of a salt into its constitents, while in this case it seems to be true dissociation of a polymeride into its simpler and more stable form. Such polymerisation is quite comparable with that exhibited by aldehyd, cyanogen, and some other substances, though from the ready solubility of the product the phenomenon is in this case by no means obvious. Oudemans also hints at the possibility of some molecular combination, but this is quite different from a polymeride possessing new and opposite optical properties.

Consider the conditions in such a solution. At any given concentration let m be the number of normal molecules and n the number of polymeric molecules, and let r and r' be their respective rotative powers. Then, evidently, the condition for reversal of rotation is that $nr' > mr$, where r and r' have opposite signs; while where $nr' < mr$ the normal rotation will be only decreased, and for $nr' = mr$ there will be no rotation. These conditions are general for any mixture of optically active substances.

For the case in question, since the molecule of one of the substances is composed of p molecules of the other, the additional condition is imposed that $np + m = A$, the total number of normal molecules before any formation of the polymer. Under these circumstances the condition for no rotation in terms of m will evidently be—

$$m = \frac{Ar'}{rp + r'}.$$

From this equation it appears that if r' were due to a crystalline form, in which p must be quite large, and were in magnitude fairly comparable to r, the change produced in the rotation would be large compared to the number of crystal molecules formed. Hence, when the change in rotation is gradual, and extends over a wide range of temperature, there is reason to suppose that p is rather small.

Further, since the rotation is a function of the wave-length according to the formula—

$$\alpha = \frac{B}{\lambda^2} + \frac{C}{\lambda^4},\dagger$$

all optically active substances must produce dispersion varying for each substance with the constants B and C, but varying in direction with the sign of α. Now if substances be mixed which give opposite signs for α, it is evident that a more or less perfect colour compensation can be effected, according to the relative magnitudes of the constants. If these were equal, perfect achromatism would follow together with absence of rotation. If they were unequal, various sorts of irregular and anomalous dispersion must result; and when the rotation of the system is completely reversed, the dispersion will have changed its direction. If one of the substances is more affected by temperature than the other, the constants will vary, and irregular dispersion must follow. Anomalous rotary dispersion is inexplicable unless the substance showing it be a mixture, for α is a function only of constants and powers of λ, and in rotary dispersion there is no analogue of absorption. Biot‡ has investigated experimentally this rotary dispersion, and found the partial achromatism, irregular dispersion, and allied phenomena indicated above.

Now these theoretical considerations are completely fulfilled by the properties of malic and tartaric acids. As

* *Liebig's Annalen*, clxvi., 73; clxxii., 60.
† Boltzmann, *Pog. Ann. Jubelband*, S. 128.
‡ *Ann de Chim. et de Phys.* (3), xxxvi., 405.

a solution of malic acid becomes more and more concentrated the lævo-rotation gradually decreases, approaches the neutral point, and then, up to the limit of saturation, becomes more and more dextro-rotatory. For a temperature of 20° the neutral point is found in a solution containing 35·3 per cent of the acid. A 70 per cent solution has a specific rotation $[\alpha]_D = +3·3°$.* The dextro-rotation of malic acid was first noticed by Arendtsen.† These phenomena are precisely what would follow the gradual formation of a polymeride; and if it is so formed, increase of temperature should break it up and restore the lævo-rotation. This actually happens;‡ and without knowledge of the fact, and proceeding on purely theoretical grounds, I found that a solution inactive at 20° could be made to pass from dextro- to lævo-rotation and back with the greatest ease. Further, it is to be noticed that the change of rotation produced by a given change in temperature grows rapidly less as the solutions used are more and more dilute, which phenomenon would be a natural consequence if a polymeride were gradually broken up by dilution, but is incomprehensible if the change is due only to rise of temperature.

In case of sodium malate, which in general shows a stronger tendency to lævo-rotation than the free acid, this phenomenon is far less marked: which seems to indicate that, there being a comparatively small amount of the polymeride formed, the change produced by its dissociation is correspondingly small. I have extended the observations given by Thomsen by measuring the change of rotation produced in a 10 per cent solution of the acid by rising temperature. From 20° to 40° in a 100 m.m. tube the change was less than 20′, from which it would appear that, in a very weak solution, the polymeride is almost completely broken up, and the change produced by heating would be little or nothing.

Tartaric acid is under all ordinary conditions dextro-rotatory, but becomes lævo-rotatory for blue rays in sulphuric acid solution,§ and completely so for solutions in anhydrous ether, acetone, or alcohol at a low temperature (as previously mentioned). Its specific rotation, like that of malic acid, increases with the temperature.

But the most conclusive evidence that could be wished is furnished by its rotary dispersion. In a 10 per cent solution the dispersion is normal, but, as the concentration is increased, anomalous dispersion appears, and passes through various phases, until in a 50 per cent solution the rotation for the blue is less than for the red; and the gradual reversal of rotation goes on till, in a 90 per cent solution, the blue is lævo-rotatory, and the dispersion is that normally belonging to a lævo substance. Furthermore, the same series of changes can be produced by changes in temperature, a 50 per cent solution showing an entirely normal dispersion at 50°.‖ From these facts it is evident enough that tartaric acid undergoes modification into a lævo-rotatory form by concentration or lowering of temperature. It has been shown that this modification cannot be due to change of configuration or to a hydrate, while the only crystalline form of ordinary tartaric acid known has optical properties opposed to those which must be attributed to the above modification. The hypothesis of a polymeric modification explains the observed facts effectively, and renders the change of specific rotation by dilution comprehensible, For it is clear that a polymeride may be dissociated in this way, since Berthelot¶ has shown by a beautiful series of thermo-chemical experiments that racemic acid, which is well known to be a combination of dextro- and lævo-tartaric acid, is partially decomposed into its constituents by the simple act of solution. An analogous case of easy dissociation is furnished by nitrogen peroxide, N_2O_4, which is broken up very readily by heat.

Whether the polymeride thus found in tartaric (and malic) acid is a true chemical compound or a physical compound it is not altogether easy to say, for the distinction is in general somewhat indefinite; but, since it is radically different from any known crystalline modification, and appears to be comparatively simple, the former view seems much the more probable. In solutions of other substances molecular aggregations certainly exist, as is shown by the thermal experiments previously mentioned, but do not exhibit any radical change of physical properties such as is here found.

The theory throws some light on the effect of solvents. One cannot fail to notice that those liquids in which tartaric acid is difficultly soluble (acetone, &c.) are the ones which most diminish its rotation. In other words, those substances which do not facilitate dissociation by affording a ready solvent medium, allow molecular aggregations to produce the most marked effects. How far this may be able to account for the action of solvents on optically active substances in general remains to be seen. The same reasoning certainly holds for malic acid.

One other important fact must not remain unnoticed in the consideration of these acids. Each of them exists in more isomeric forms than can be accounted for by any theory yet advanced. Of tartaric acid there are the two active forms and two well-known inactive forms, while Staedel has shown* that the inactive tartaric acid obtained from glyoxal differs from the others. Even van't Hoff's hypothesis, usually so liberal with isomerides, accounts for but three forms ("Die Lagerung der Atome im Raume," 37), and here are five.

With malic acid the case is much the same. There are two active forms, and probably three inactive forms, described by Bremer,† Pasteur,‡ and Loydl.§

Racemic acid seems to be very closely related to the other inactive acids. Now, in racemic acid there is good reason to believe the molecule to be made up by a combination of right- and left-handed molecules. If we consider how a dextro- and a lævo-form may be thus united and produce optical inactivity, it seems quite probable that they must be arranged with reference to a plane of symmetry. Considering now a body containing an asymmetrical carbon atom, and existing in dextro- and lævo-forms, the probability appears that such forms may be united each to each symmetrically to a plane, in four, and only four, different ways.

May it not be that the unexplained isomerides of racemic acid, and the corresponding malic acid, which we believe to be combinations of right and left forms, differ from each other only in position with reference to their common plane of symmetry?—*American Chemical Journal*, vol. vii., No. 2.

* Schneider, *Liebig's Annalen*, ccvii., 262.
† *Ann. de Chim. et de Phys.*, (3), liv., 403.
‡ Th. Thomsen, *Ber. d. Deut. Chem. Ges.*, xv., 441.
§ Biot, *Ann. de Chim. et de Phys.*, (3), x., 385.
‖ Krecke, *Archives Néerlandaises*, vii., 107.
¶ *Comptes Rendus*, lxxviii., 713.

MR. J. B. DANCER.

SOME days ago there appeared in the Manchester papers a letter from Mr. J. B. Dancer, recalling to our notice the large share that gentleman took in the introduction of photography to Manchester and Liverpool. But photography is only one of the many arts and sciences indebted to him; and though it is neither possible nor necessary to give a detailed catalogue of those services, the list that follows cannot be without interest to the Manchester public, whose townsman Mr. Dancer has been for more than half his lifetime.

Of his connection with photography he has himself written, though in the modest and imperfect way one would expect such a man to write about himself. There is the stereoscopic camera with twin lenses, which, as he explained, he was the first to make. He invented micro-

* *Ber. der Deut. Chem. Ges.*, xi., 1752.
† *Ibid.*, xiii., 351.
‡ *Ann. de Chim. et de Phys.* (3), xxxiv., 46.
§ *Liebig's Annalen*, cxcii., 80.

scopic photographs, which so much delighted and astonished us twenty-five or thirty years ago. He also introduced photography to the magic lantern, being the first to show a photographic transparency on a screen; and the exhibitions which men of middle age will so well remember at the Mechanics' Institution, when Mr. E. Hutchins was the secretary, were largely due to Mr. Dancer, and were the first ever held. The lantern itself is also indebted to him, not only in its optical parts and its construction generally, but also particularly in the application of the oxy-hydrogen light, and for a dissolving gas-tap, which saves half the gases and produces the best dissolving effect.

Then there should be mentioned, as of much greater importance than the above, the automatic "contact breaker," used probably by the million at this moment, in every induction coil in the world. Prior to Mr. Dancer's invention contact used to be made and unmade by hand, in a vessel containing mercury. The first helical coil with the vibrating interrupter was constructed by Mr. Dancer, and was exhibited long after by him at one of the soirées of the British Association, when the meeting was held in Manchester.

When Mr. Dancer established himself as an optician in Manchester, his presence soon made itself felt amongst the few microscopists then living in the district. Good microscopes were then costly, and worthless ones very common. Mr. Dancer successively brought out several forms of instruments, as excellent in their mechanical and optical arrangements as they were moderate in price. Instruments fully equal to the requirements of original research were thus brought within the reach of many whose observing faculties were more conspicuous than their financial resources. It would be difficult to overestimate the stimulus which Mr. Dancer thus gave to Manchester microscopy; it cannot be doubted that the present energy of our local microscopists is the direct outcome of the impulse which their means of research then received.

Not only so, but the value of the new instruments was recognised outside our city, by such men as Mr. Quekett, Dr. William Carpenter, Dr. Gideon Mantell, and Mr. Bransby Cooper, all of whom were familiar with their excellent qualities. These facts suggest that Mr. Dancer's claims upon us are worthy of recognition by many now treading in paths which he made easy for them, though personally a stranger to them.

This is a considerable catalogue for one man to be concerned in; but it does not complete the list. Mr. Dancer mentions the porous jar in his letter, which he was the first to suggest in the Daniell's battery, and which it is difficult to over-estimate the importance of. There are also his improvements in levels; the speed counter; an instrument for testing coloured fabrics for calico printers; improvements in air-pumps; improvements in voltaic batteries, &c., &c.

It is sad to have to say, that notwithstanding Mr. Dancer's talents and achievements, he is now living in very straitened circumstances, is moreover afflicted with almost total blindness, and therefore unable to follow the optical business to which his life has been devoted. It is not an unusual thing for a man of great mechanical ingenuity and skill to be an indifferent man of the world, and so it has been with him; as a business man he has been a failure. He has made improvement after improvement, invention after invention, any one of which might in "pushing" hands have made a fortune; but more interested in science than in money-making, he has allowed the golden chances to become public property, and has thus remained poor himself, while the world has reaped the advantage of his labours.

Mr. Dancer is now in his seventy-fourth year, and we beg respectfully to suggest that in his hour of darkness the world should pay back to him something for that which it has freely received at his hands.

We propose that a subscription be commenced forthwith, with the object of purchasing an annuity, payable during the joint lives of himself and Mrs. Dancer.

We are willing to form the nucleus of a committee for carrying out this project, and invite all friends to Mr. Dancer to join us in obtaining subscriptions. Mr. T. R. Wilkinson, manager of the Manchester and Salford Bank, has consented to act as treasurer, and cheques can be paid to his order, or payments to the credit of the "Dancer Subscription" will be received at the Bank.

J. P. Joule, LL.D., F.R.S., Sale, near Manchester.
Prof. W. C. Williamson, LL.D., F.R.S., Owens College.
Prof. Balfour Stewart, LL.D., F.R.S., Owens College.
John Dale, F.C.S., Cornbrook, Manchester.
Leo H. Grindon, Manchester.
S. Platt, J.P., Oldham.
Charles Bailey, Hon. Treasurer Manchester Literary and Philosophical Society.
James Birchall, Hon. Sec. Liverpool Literary and Philosophical Society.
Abel Heywood, Jun., Higher Broughton, Manchester (Hon. Sec. pro tem.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 17th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Alfred Rée, Apperley Bridge, near Leeds; Vivian Phelps Richards, 28, Boscombe Road, Shepherd's Bush, W.; Laurence Hislop, Saltney, Chester; Frank Thomas Shutt, B.Sc., Rosedale Cottage, Toronto, Canada.

The following were duly elected Fellows of the Society:—Thomas Akitt; James Blake, M.D.; Alfred Chaston; A. W. H. Chapman; Augusto Cæsar Diojo; Charles A. R. Jowitt; Charles Alexander Kohn; John Temple Leow; William Ray; Joseph Price Remington; William Richards; Forbes Rickard; William Saunders; Charles A. Smith.

The following papers were read:—

60. "*The Electrolysis of Aqueous Solutions of Sulphuric Acid, with Special Reference to the Forms of Oxygen obtained.*" By Prof. H. McLeod, F.R.S.

The experiments were instituted to determine the quantity of ozone that can be obtained by electrolysis. The negative electrode consisted of a small platinum plate, and the positive of a tube containing mercury, and with fine platinum wires of 0·045 m.m. and 0·027 m.m. in diameter fused into the glass. Several wires were used, the total length being about 6 m.m. The electrolysis was carried out in a U-tube surrounded by ice and water; the hydrogen was collected over water, and the ozonised oxygen passed through a tube containing a solution of potassic iodide, the oxygen being afterwards collected. The quantity of ozone was determined by acidifying the potassic iodide solution and decolourising by a standard solution of sodic thiosulphate. In the electrolysed acid an oxidising substance is present which is not hydroxyl, but is probably Berthelot's persulphuric acid. The amount of this "active oxygen" was found by adding potassic iodide to the liquid and decolourising by the solution of thiosulphate. The electric current was measured by a tangent galvanometer, and the dimensions of the wires of the positive pole were determined: from these data the intensity of the current was calculated. Acids were used of relative densities varying between 1·025 and 1·7. The maximum quantity of ozone was obtained with solutions about

1·075 or 1·1 in density, the electrolytic oxygen containing about 16 or 17 per cent of its weight of ozone. The maximum quantity of "active oxygen" in the oxidising substance referred to was produced with acids about 1·2 to 1·25 in density, the proportion being 16 or 17 atoms to 100 atoms of hydrogen.

The solubility of ozone was determined by one experiment, and found to be much greater than that of oxygen.

A note is added to the paper detailing some experiments on the action of oxygen on chlorhydric acid under the influence of light: it was found that a considerable quantity of chlorine was liberated.

Discussion.

Mr. Friswell said that Prof. McLeod's observation explained a fact that had come under his notice years ago, viz., the constant presence of chlorine in muriatic acid.

The President said that he also had noticed this, and had found that chlorine was always contained in the acid if it had been exposed to the air.

Mr. Laurie suggested trying aluminium electrodes; he had noticed a very distinct smell of ozone on electrolysing dilute sulphuric acid with poles of this metal.

61. "*Essential Oils* (Part III.): *their Specific Refractive and Dispersive Power.*" By Dr. J. H. Gladstone, F.R.S.

Since the appearance of the author's former papers on essential oils, in 1863 and 1872, many investigations have been published; but important divergences of opinion still exist among chemists as to the rational constitution of these compounds. He now brings forward arguments founded on the phenomena of refraction and dispersion, believing that in the conflict of opinions such arguments ought to have considerable force. For this purpose he employs the refraction equivalent for the solar line A, as compared with that calculated from the known values of carbon and hydrogen and the known increase on account of the double linking of carbon atoms. But he also introduces a new conception, that of dispersion equivalents, being the difference between the refraction equivalents for the lines A and H, or—

$$P\frac{\mu_H - \mu_A}{d},$$

where μ and d are the refractive index and relative density and P the atomic weight. It is found that the dispersion equivalent of carbon may be taken at 0·25, and that of hydrogen at 0·045, as a first approximation, while in the case of benzenoid compounds the addition to be made to the dispersion equivalent on account of each double linking of carbon atoms is fully 0·8.

The paper deals mainly with the $C_{10}H_{16}$ hydrocarbons. These are divisible on account of their physical and chemical properties into two large groups, the terpenes and the citrenes. There are also the solid camphenes and the cedrenes or CH_{24} hydrocarbons. The optical properties of the terpenes are in close accordance with what may be expected from a compound in which one pair of carbon-atoms is double linked; those of the citrenes indicate two pairs; while camphene has a slightly slower specific refraction and dispersion, however, than a terpene. The cedrenes appear to be strictly polymeric with the terpenes from an optical point of view.

The optical properties of caoutchouc were also examined. Its principal constituent resembles the citrenes;

	Refraction equiv.		Dispersion equiv.	
	Observed.	Calc.	Observed.	Calc.
Terpenes, natural ..	73·0	73·0	4·0	4·02
„ artificial ..	72·9	73·0	3·9	4·02
Camphene	72·9	73·0	3·7	4·02
Cedrenes	109·8	109·5	6·1	6·03
Citrenes, natural ..	75·0	75·2	4·5	4·82
„ artificial ..	75·1	75·2	4·6	4·82
Caoutchene	75·3	75·2	5·0	4·82
Isoprene	40·3	39·8	3·2	3·21

so also does the liquid hydrocarbon, $C_{10}H_{16}$, that is produced by its dry distillation. Isoprene, C_5H_8, also must have two pairs of its carbon-atoms double-linked, a result which agrees with Tilden's conclusions from its chemical properties.

Armstrong's cymhydrene, $C_{10}H_{20}$, Atkinson's menthene, $C_{10}H_{18}$, citrene, $C_{10}H_{16}$, and cymene, $C_{10}H_{14}$, form a series: the first being a saturated compound and the others having respectively one, two, and three pairs of carbon-atoms double-linked.

Discussion.

Prof. Tilden asked whether Dr, Gladstone had made any special attempt to determine the composition of the cedrenes; they were commonly regarded as $C_{15}H_{24}$ hydrocarbons, but the difference in composition between $C_{15}H_{24}$ and $C_{15}H_{26}$ was so slight that it was conceivable that the cedrenes were in reality homologues of the terpenes.

Dr. Gladstone said that this suggestion was novel to him.

Dr. Armstrong thought that while Dr. Gladstone's observations agreed with the chemical evidence in assigning the terpenes to a position intermediate between the camphenes and citrenes, the chemical evidence did not harmonise with the assumption that the terpenes contained only a single pair of "double-linked" carbon atoms; in this respect the terpenes and citrenes must be classed together. In point of fact the $C_{10}H_{16}$ hydrocarbons manifest peculiarities which at present do not admit of satisfactory representation by a symbolic expression.

62. "*The Formation and Destruction of Nitrates and Nitrites in Artificial Solutions and in River and Well Waters.*" By J. M. H. Munro, D.Sc.

Most of the experiments recorded in this paper were made in the years 1883 and 1884, the method followed being that adopted by R. Warington and described in his Second Report on Nitrification (1879).

Many of the general conditions of nitrification, as stated by Schlœsing and Muntz, and by Warington, have been confirmed. For example, in no case has nitrification occurred in a solution sterilised by boiling after being seeded with soil and left unopened until tested after an interval of as much as three years. Mercuric chloride, lead acetate, and chloroform are all equally fatal to nitrification. As an instance of the slowness of the process in some cases, a solution of 2 grms. per litre of ammonium chloride seeded with 2 grms. of soil commenced nitrifying only after an incubation of three months, and required two years and ten months for complete nitrification; but when a fresh solution of 1 grm. per litre of ammonium chloride was added bodily to this nitrified solution, it commenced to nitrify after an incubation of only five days.

Amongst nitrogenous bodies other than ammonium salts, *ethylamine hydrochloride*, *gelatin*, *potassium* and *ammonium thiocyanate*, and *urea* are all easily susceptible of complete nitrification in contact with soil. In all these cases ammonia is first formed, and nitrite appears at a subsequent stage, finally passing into nitrate. Thio-urea has resisted repeated attempts to nitrify it.

Several experiments are cited to show that the organic carbon required in a solution prepared for nitrification is infinitesimal in proportion to the quantity of ammonium salt nitrified. Thus 63 m.grms. ammonium chloride have been completely nitrified to nitrite without any added organic carbon. When an alkaline tartrate or any similar organic matter is included in a solution prepared for nitrification (as has been the case in all published experiments), it delays nitrification, and even brings about a destruction of any nitrate that may pre-exist in the solution *unless all other germs than those of the nitrifying organism are rigorously included*. It does this because it encourages a growth of *denitrifying bacteria*, the germs of which exist in the air, in soil, in natural waters, and generally even in the few drops of nitrifying solution em-

ployed as seed. Until these bacteria have run their course and died, nitrification does not commence, and hence there is a period of apparent incubation even in solutions otherwise ready for immediate nitrification. By using soil as seed and excluding all other added organic matter, a first solution of ammonium chloride may be caused to commence nitrifying in three or four days; if after nitrification this is poured off and replaced by a second solution, nitrification commences in 24 hours; and a third solution employed in a similar manner may (under favourable circumstances) be seen to have commenced nitrifying in seven hours.

Well and river waters, since they contain organic matter not fermentible by denitrifying bacteria, form suitable media for the study of nitrification. The salifiable base (calcium carbonate) and the traces of necessary minerals are also present in suitable proportions and in such a form as not to interfere with the perfect transparency of the solutions. Such waters, boiled and filtered and seeded with a little soil, or a few drops of a nitrifying solution, will nitrify added ammonium chloride to the full saturating capacity of the calcium carbonate contained in them. The process usually takes 30—40 days at the ordinary temperature.

The question as to how far these natural waters contain the nitrifying organism independently of added soil has also been carefully tested. A suitable quantity of ammonium chloride solution (5 c.c. = m.grm. NH_3) is boiled in a sterilised flask plugged with cotton-wool; on cooling, the plug is removed for a moment while the flask is half filled with the water to be examined. A cap of paper is then tied over the flask, which is placed in a warm place (not over 85° F.) for 18—30 days and then opened and tested. If the water possess any nitrifying power some nitrite will almost certainly be found at the end of this period by the metaphenylenediamine test. Eleven waters tested in this way were found to possess nitrifying powers in different degrees: they included river-water, seven well-waters, water from a coal-pit level, rain-water from a brick cistern, and water from the Bristol Waterworks Company's main. The wells with sewage contamination, present and past, nitrified readily: probably because the nitrifying organism has already undergone a period of incubation and is in full activity. River water commences nitrifying after 9 days, and finishes on the 46th day, nitrite being present as late as the 42nd day. The addition of 1 per cent of soil hastens the process and lessens the production of nitrite. The only water which failed to produce nitrification after an incubation of 18 days at 80—85° F. was rain-water caught from the clouds in a sterilised beaker and added to boiled well-water. Well-water will produce a purely nitrous or a purely nitric fermentation, according to circumstances, and the nitrite may persist for at least two years without further oxidation. The nitrifying power of a well-water is not removed by filtration through Swedish paper, and is even increased by filtration through a charcoal filter in common use. The waters remain practically clear throughout, and the deposit is extremely slight; as they encourage the growth of the nitrifying organism almost exclusively (in the dark) they are probably well suited for microscopic observation of this organism.

Denitrification.—An alkaline tartrate, acetate, or oxalate, sugar, glycerol, or in fact *any* fermentible organic matter, if added to well-water, produces a bacterial reduction or destruction of the nitrate pre-existing in the water. The tartrate, acetate, or oxalate is destroyed with formation of an alkaline carbonate. The water becomes opalescent in 3—4 days, and consistently with this a trace of nitrite is found. In a few more days all the nitrate may be reduced to nitrite. In good waters the reduction may go no further. In many polluted waters, the nitrate and nitrite are totally destroyed, nitrogen gas being evolved. The same effect is produced by the addition of a few drops of sewage to the water, *if the water contain any fermentible organic matter.* Even salicylic acid and phenol lend themselves to this reduction, although they are fatal to nitrification. MM. Gayon and Dupetit, in a memoir published since this paper was in MSS., have examined this phenomenon in great detail by the culture of the denitrifying bacteria in highly artificial solutions. The bacteria which effect the reduction to nitrite in presence of organic matter are common in the air, waters, and soil. Those which destroy the nitrate or nitrite with evolution of nitrogen gas were obtained by MM. Gayon and Dupetit from sewage.

63. "*Water of Crystallisation.*" By W. W. J. NICOL, M.A., D.Sc., F.R.S.E.

The paper is a reply to Professor Pickering's criticism of the author's experiment on the molecular volumes of salts in solution (*Trans.*, 1886, 411—432). The author maintains the accuracy of his experiments and of the conclusions derived from them, which are that when a salt is dissolved water of crystallisation is indistinguishable from solvent water, both having the same volume; and that water of constitution has in solution a volume markedly different from that of solvent water. Hence it seems certain that water of crystallisation does *not* exist in solution, but that the whole of the water present is in the same relation to the salt, no hydrate definite or indefinite existing in solution. This is supported by experiments on supersaturation, the author having prepared supersaturated solutions from dehydrated salt and *cold* water: the salt dissolving with evolution of heat but without the formation of a hydrate.

DISCUSSION.

Mr. PICKERING said that he did not wish for one moment to call in question Dr. Nicol's results, and he even agreed with him so far as to admit that the work showed no difference between combined water and water of solution; but this was a very different thing to saying that it proved that no water was combined with the salt. He had ample reason for considering that this was a case in which negative evidence proved nothing.

He considered that Dr. Nicol's experiments on the magnesium sulphates afforded the strongest evidence which we have of one of the water molecules contained in them being different from the rest. At the same time he thought that that evidence was far too slight to warrant any positive conclusion being drawn; and even if it proved that such a difference did exist, it would not prove that this one molecule was so-called constitutional water. A discussion of the thermal phenomena attending dissolution would open the whole question of the nature of solution, into which it was impossible then to enter. Although Mr. Pickering could not accept Dr. Nicol's theory of solution, he by no means adhered to what is ordinarily understood by the "hydrate theory." It was impossible, he thought, to draw any general conclusions as to the nature of solution from the behaviour of one of the most exceptional salts which we know, sodium sulphate.

Dr. NICOL said that he was glad to hear that Mr. Pickering had no wish to call in question the accuracy of his results, for that was not the impression to be gathered from Mr. Pickering's paper. As to negative evidence proving nothing, he thought that it should have at least as much weight as an affirmative statement, unsupported by any evidence other perhaps than the colour of cobalt and copper chlorides. In using the term constitutional water, he had no intention of committing himself to more than the statement that one water molecule was differently related to the salt in solution from the remainder of the water. With regard to the dissolution of a dehydrated salt without the intermediate formation of a hydrate, he had used sodium sulphate as the most convenient, but had performed similar experiments with sodium thiosulphate, magnesium sulphate, and other salts. He was of the opinion that such experiments are conclusive evidence against the existence in solution of hydrates of these salts.

Dr. ARMSTRONG called attention to T. Thomsen's recent observations on the supposed division of the water between

two bodies in solution (*J. Pr. Chem.*, 1885, xxxii., 211; *Chem. Soc. Abs.*, 1886, 12).

64. "*A Method of Investigation the Constitution of Azo-Diazo-, and Analogous Compounds.*" By R. MELDOLA, F.R.S., and F. W. STREATFEILD.

The method described consists in displacing the hydrogen in such compounds by alkyl radicles and then decomposing by heating with acids or by complete reduction. The compound described in the present paper is paradinitrodiazoamidobenzene obtained by treating paranitraniline dissolved in chlorhydric acid with the necessary quantity of sodium nitrite. The formula of this substance is that of a true diazoamidoazo-compound, viz.,—

$$NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}NH{\cdot}C_6H_4{\cdot}NO_2.$$

On reduction by tin and hydrochloric acid it gives only paraphenylenediamine. It is a a strongly acid substance, the H of the $\cdot N_2.NH\cdot$ group being displaceable by metals with the formation of crystalline salts. It is remarkably stable in the presence of alkalies, but is decomposed on heating with acids. It differs from other diazoamido-compounds, however, in not furnishing a phenol as a product of decomposition by acids. With dilute sulphuric acid it gives paranitraniline and a tarry substance, and with chlorhydric acid, paranitraniline and paranitrochlorbenzene:—

$$NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}NH{\cdot}C_6H_4{\cdot}NO_2 + HCl = \\ = N_2 + NO_2{\cdot}C_6H_4Cl + NO_2{\cdot}C_6H_4{\cdot}NH_2.$$

By acting with ethyl iodide upon the sodium salt the ethyl-derivative, $NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}N(C_2H_5)C_6H_4{\cdot}NO_2$, is obtained. The original substance forms small yellow needles, melting with decomposition at 223°. The ethyl-derivative melts at 191 to 192°. The last compound does not form salts; it is decomposed by dilute sulphuric acid into ethyl paranitraniline and resinous products, and by chlorhydric acid into paranitrochlorobenzene and ethylparanitraniline. The ethylparanitraniline forms a nitroso-derivative (m. p. 119·5°), which is described in the paper. The authors point out that the decomposition of the ethyl-derivative into ethylnitraniline and nitrochlorbenzene is conclusive evidence against the symmetrical formulæ—

$$NO_2{\cdot}C_6H_4{\cdot}N{-}N{\cdot}C_6H_4{\cdot}NO_2;\quad NO_2{\cdot}C_6H_4{\cdot}N{-}N{\cdot}C_6H_4{\cdot}NO_2$$
$$\qquad\qquad\quad \diagdown\diagup \qquad\qquad\qquad\qquad\quad \diagdown\diagup$$
$$\qquad\qquad\quad NH \qquad\qquad\qquad\qquad\quad N(C_2H_5)$$

for this compound and the original substance. They propose to extend the investigation to other diazo-, azo- and oxyazo-compounds.

(To be continued.)

PHYSICAL SOCIETY.

June 12th, 1886.

Dr. J. H. GLADSTONE, Vice-President, in the Chair.

THE following were elected Members of the Society:—Dr. Samuel Rideal and Mr. E. C. Wellington.

The following communications were read:—

"*On an Electric-Light Fire-Damp Indicator.* By Messrs. WALTER EMMOTT and WILLIAM ACKROYD.

The Royal Commission on Accidents in Mines point out, in their recently issued Report, as a serious objection to the use of the electric light in mines, notwithstanding its many great advantages, that the light of an incandescent lamp being produced within a vacuum cannot admit of any device for the indication of fire-damp, such as is given by the Davy, for example. The present apparatus is the outcome of an attempt to overcome this difficulty. It consists of two incandescent lamps, one with colourless and the other with red glass, and the circuit is so arranged that in an ordinary atmosphere the colourless lamp alone shines, but in fire-damp this goes out and the red one is illuminated. This is effected in a simple manner by the motion of a mercury-contact occupying the lower part of a curved tube, one end of which is open and the other connected with a porous pot of unglazed porcelain, the motion of the mercury being due to the increased pressure in the porous pot occasioned by diffusion.

"*On a Method of Distinguishing Rays of Solar from those of Terrestrial Origin.*" By Prof. CORNU.

It has been shown, by M. Fizeau, that, owing to the rotation of the Sun upon its axis, there is a displacement of the spectral lines produced by solar absorption towards the red or towards the violet, according as to whether the light examined emanates from those parts of the Sun which are receding from or approaching us. If, however, the lines are the result of absorption by the Earth's atmosphere, no such displacement should occur. It has been the aim of the author to make this principle the basis of a simple and instantaneous method of determining the origin of any given line. The displacement is very minute, amounting to about 1-150th of the distance between the D lines for rays in that part of the spectrum when the light is from the extremity of the Solar Equator, but it has been found quite sufficient. Observations have been made with a Rowland grating, the mean distance of the lines being 0·00176 m.m. An image of the Sun is formed upon the slit of the spectroscope by a lens. By a slight oscillatory motion given to the lens by a lever from the hand any part of the Sun's image can be brought upon the slit. A heliostat sends the rays always in the same direction, and by a prism the image has its equator horizontal. To distinguish between a line of solar and one of terrestrial origin the line is brought near the vertical wire of the eye-piece, or, better still, one of those inevitable grains of dust which are always seen on the horizontal wire. The lever connected to the lens is then oscillated so as to bring alternately the two ends of the Solar Equator tangentally upon the slit. If the ray is of terrestrial origin it remains absolutely fixed; if it is solar it oscillates with the lever.

"*On a Hyperbolagraph.*" By H. H. CUNNYNGHAME.

It is not an infrequent want to be able to find a rectangle of greatest or least area contained between a curve and rectangular co-ordinate axes. In several problems connected with motion and pressure in steam-engines this is useful, and even in political economy the graphic representation of monopoly curves depends on maxima and minima of this nature. For the solution of such problems it is often very useful to be able to describe rectangular hyperbolas, and the author has devised a machine to effect this. It depends on a mathematical property of the rectangular hyperbola which he believes to be new, and which is as follows:—From a fixed point let any line be drawn to meet a fixed line, and from the point of meeting draw a line perpendicular to the fixed line and equal in length to the first line. The locus of the extremity of the second line is a rectangular hyperbola; or, if from a fixed point O a line O P be drawn to meet a fixed line in a point P, and P Q be taken perpendicular to the fixed line, so that O P+O Q be constant, then again the locus of Q is a rectangular hyperbola. In the machine the latter construction is mechanically and continuously carried out. A pencil, whose point corresponds in position to the point Q, slides along a rule which is carried across the paper always perpendicularly to the fixed line. A fine steel wire attached to the pencil passes once round a roller at P, and is then carried to and coiled round a similar one at O. The use of a steel wire is a special feature of the apparatus, and has a great advantage over string, which, owing to the facility with which it stretches, cannot give good results. The finest wire should be used; it unrolls from the one roller as much as it laps over the other, and its use may be extended to nearly all curve-drawing machines.

A Voltaic Cell with a Solid Electrolyte was exhibited by SHELFORD BIDWELL. Its construction is as follows: Upon a plate of copper is spread a layer of quite dry pre-

cipitated sulphide of copper. If on this a clean plate of silver is placed, and the cell joined up to a galvanometer, a slight deflection is observed, due to the unavoidable presence of moisture. If, however, the silver plate be covered with a slight film of sulphide of silver, by pouring on it a solution of sulphur and bisulphide of carbon, and evaporating the free sulphur by heat, and then placed with the prepared side down as before, a deflection is obtained far greater than, and in the opposite direction to, the former. The resistance of the cell was very great, but was enormously reduced by compression; the E.M.F. was about 0·07 volt.

NOTICES OF BOOKS.

The Elementary Principles of Electric Lighting. By Alan A. C. Swinton, A.S.T.E.

In this book of under thirty pages the author succeeds in making clear the principal points which it is necessary anyone should understand to enable one to superintend an installation for electric lighting. The various heads are lightly dwelt on and clearly explained in a few words; we think, however, that a little more space might have been given to explaining the methods of testing roughly for leakage and faults in the cables.

There is one great danger in small books of this kind, and that is that men, having assimilated them thoroughly, will then consider themselves competent electricians, without troubling to read more advanced treatises on the subject.

If, however, this book is looked upon as a mere stepping stone to help a practical man to understand his work it will probably induce a desire for further knowledge, and thus fulfil the promise set forth by the author in the latter part of the preface.

Bread-Analysis: a Practical Treatise on the Examination of Flour and Bread. By J. Alfred Wanklyn and W. J. Cooper. London: Trübner and Co.

This work has made its first appearance in the present year, though the preface is dated March 1st, 1881. It may be to a certain extent regarded as a development of a chapter on "Flour and Bread," contributed by Mr. Wanklyn to the *Manual of Public Health* as far back as 1874. It is addressed, we are told, principally to Public Analysts, but two chapters are arranged with a view to the edification of a wider public.

In the first chapter the authors describe flour, its constituents, and bread, the latter substance being further considered in the following chapter. Very interesting facts are here brought forward concerning the proportion of water present in bread. When well made it should contain about 34 per cent of moisture, and consequently 66 per cent of bread solids. But in practice the moisture rises to and even exceeds 40 per cent, the bakers thus, as the authors duly word it, "accomplishing the profitable commercial operation of making 60 lbs. of bread solids do duty for 66 lbs." That such excess of moisture is very prevalent we find proved by the analysis of 42 samples obtained from various bakers at Peterborough. Of these 17 gave a mean moisture of 40 per cent, 11 others gave a mean of 34, the rest being intermediate. It is remarked that "bread which is too moist is prone to grow mouldy, and some years ago a government investigation in France traced a serious outbreak of disease in the French army to the poisonous character of a quantity of too moist bread which had formed the rations." In this case the moisture was determined by Payen as 50 per cent. The occurrence of fungoid growths in bread—a consequence of excess of moisture—"suggests the question whether the mortality does not, in some instances, resolve itself into a case of wholesale poisoning by unwholesome fungi." Hence the author's proposal that a standard for moisture ought to be established and appended to the Sale of Food and Drugs Act deserves very serious consideration. As regards adulterations of flour, the authors are of opinion that in their practice as Public Analysts they have never found any instance of those gross forms of adulteration which consist in adding 10 to 20 per cent chalk, gypsum, or bone-ash to flour. They consider, however, that possibly in time of war an army contractor might result to such frauds. Alumed bread, too, is pronounced rare.

For carrying out the determination of nitrogen the authors consider both the Will-Warrentrap and the Dumas process inadequate, and recommend the same process proposed by Messrs. Wanklyn, Chapman, and Smith for determining ammonia in water.

On the great "bread-reform movement" the authors pass a decisive judgment. They are of opinion that "the futility of the resort to whole-meal in order that bone-forming material may be administered is manifest."

In the last chapter the authors, somewhat curiously, take up arms in defence of corn-flour. They brand the attempts "made from time to time to disparage corn-flour" as irrational. But corn-flour, as it is erroneously called, is, as the authors themselves show, starch with only 0·24 per cent of mineral matter. Now it is indisputable that starch cannot form blood or bone, and that it is, with the single exception of cellulose, the cheapest product of the vegetable world. Hence it is a singular proceeding to take, *e.g.*, maize, to eliminate from it its albumenoids, its fatty matter, and its sugar—all its most valuable constituents—and then to sell the residue at a higher price than the original maize-meal. The result of a variety of mixtures advertised for the use of young children, and consisting almost exclusively of starches, is well known to medical practitioners. On this subject the reader may be referred to a recent memoir by Dr. Stutzer in the *Pharmaceut. Centrall-Halle.*

The analytical methods given in the work before us are as a rule suitable and judicious. Attention must be called to certain typographical errors.

A Manual of the Alkali Trade, including the Manufacture of Sulphuric Acid, Sulphate of Soda, and Bleaching-Powder. By John Lomas. Second Edition, with Additions. London: Crosby Lockwood and Co.

It speaks no little for the merits of this work, considering its necessarily expensive character, that a re-issue has already become necessary. On comparing this edition with the former one we find no difference either in the text or in the illustrations. Appendix E, however, is an important addition, comprising, as it does, an abstract of the "Alkali Act" of 1881. As alkali manufacturers, and many other manufacturing chemists, come under the provisions of this Act, some of which are sufficiently drastic, this section will be duly appreciated by the trade.

In connection with this Act, which we have noticed some time ago, we may ask whether it is fair that a former inspector should advertise his readiness to supply manufacturers with practical information gained during the discharge of his official duties? We incline to the opinion that all knowledge thus acquired should be kept a secret.

On Malonic Dinitrile.—L. Henry.—Malonic nitrile is a solid, white, crystalline body, fusible at 29° to 30°, and distilling under the ordinary pressure at 218° to 219°. It is probably polymerised by the prolonged action of heat.—*Comptes Rendus.*

Combinations of Zinc Chloride with Hydrochloric Acid.—R. Engel.—The author has obtained certain hydrochlorates of zinc chloride stable at the ordinary temperature, and has further found that anhydrous zinc chloride may exist in presence of an aqueous solution of zinc chloride.—*Bull. de la Soc. Chim. de Paris.*

CORRESPONDENCE.

PURIFICATION OF AIR.

To the Editor of the Chemical News.

Sir,—In your last number (Chem. News, vol. liii., p. 296), Mr. Warington offers an explanation of the striking phenomenon which I had occasion to point out in a paper on "The Distribution of Micro-organisms in Air," communicated to the Royal Society on the 10th inst., that when air is slowly drawn through a two-foot tube coated internally with gelatin, it deposits practically the whole of the micro-organisms which it carries in suspension within the first half of its course through the tube. I am of opinion that Mr. Warington's suggestion cannot be the correct explanation of this phenomenon, but that the deposition must be due to the action of gravity alone: for if any other agency, such as the internal movement of the air propelling the suspended particles against the sticky walls of the tube, were the cause, then the micro-organisms from the air would be found almost equally distributed on all portions of the internal circumference of the tube, whilst, as a matter of fact, they are practically confined to the *bottom* of the same, upon which they are naturally precipitated by the force of gravity.

It would from this appear probable that micro-organisms are usually present in air attached to comparatively heavy particles of matter, and that their presence is by no means co-extensive with the more finely divided dust which is revealed by a sunbeam.—I am, &c.,

Percy F. Frankland.

Normal School of Science,
South Kensington Museum,
June 21, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 23, June 7, 1886.

Combustion and Formation-Heat of Sugars, Carbohydrates, and Congeneric Polyatomic Alcohols. MM. Berthelot and Vieille.—The authors have experimented on mannite, dulcite, lactose, saccharose, cellulose, starch, inuline, and dextrine.

New Observations on the Ammonia in Soils.—MM. Berthelot and André.—A continuation of the author's controversy with M. Schlœsing, with whom, however, they are at one on many points. They hold that, as for the nitrates formed and the ammonia itself, fixed or formed in the soil, it is impossible to pronounce on their true origin if we omit, as M. Schlœsing has done, to determine the nitrogenous organic matters. The slightest transformations of these nitrogenous matters, whether by microbia or by other reactions, exert a preponderating influence on the fluctuations of ammonia in the soil.

Atomic Weight and Spectrum of Germanium.—Lecoq de Boisbaudran.—Will be inserted in full.

Researches on Gelatin.—P. Schützenberger.—The author has taken up the study of the collagenous substances, such as gelatin and osseine, with the view of examining the constitution of the amidic or imidic compounds, less hydrogenous than the homologues of glycocoll.

Influence of Anæsthetic Vapours upon Living Tissues.—R. Dubois.—The author's researches extend chiefly to the action exerted by the vapours of chloroform, ether, carbon disulphide, and alcohol upon the protoplasm of animal and vegetable tissues. The vapours of these liquids have the power of penetrating into the interior of the tissues and of becoming substituted for the water which they normally contain without changing the colloidal form of the protoplasm. This is not a phenomenon of desiccation or of osmose; a true affinity comes into play, the protoplasm absorbing the vapours of the anæsthetic liquids and expelling a certain quantity of water in the liquid state. This property explains the antiseptic action of such vapours, as the spores require to absorb water for their development. Small proportions of these vapours suffice to expel a relatively considerable quantity of water. The action is so much the more rapid and powerful as the vapour of the liquid in question is more anæsthetic; they may be arranged according to their activity in the following decreasing order: chloroform, benzol, carbon disulphide, ether, alcohol. We have here a phenomenon of substitution analogous to those studied by Graham when he caused ether, alcohol, &c., to act upon colloidal mineral hydrates.

Extension of the General Law of Solidification to Thymol and Naphthaline.—F. M. Raoult.—Between zero and 80°, and probably between much wider limits of temperature, the general law of congelation or solidification is applicable to all solvents of organic nature, whatever may be the temperature at which they solidify.

Action of Hydrogen Acids upon Vanadic Acid.—A. Ditte.—It has been previously shown that certain oxy-acids can combine with vanadic acid; those which, like sulphurous acid, are greedy of oxygen reducing it in a greater or smaller degree. The hydracids of the halogenous family also play the part of reducers. Hydriodic acid, added to a hot solution of red vanadic acid, forms crystals of the composition $2VO_3I,3HI,2oHO$, which, after exposure for a few days in a dry vacuum, cease to fume in the air and lose hydriodic acid and water. The compounds thus obtained are derivatives of hypovanadic acid and not of the oxide VO_3. The behaviour of hydrobromic acid is similar to that of hydriodic acid. With hydrochloric acid there is produced an oxychloride derived from hypovanadic acid. The behaviour of hydrofluoric acid is quite different and requires a separate study.

Action of Lead Oxide upon Ammonium Hydrochlorate.—F. Isambert.—The gas disengaged in a vacuum by the reaction of lead oxide upon ammonium hydrochlorate acquires, after the expiry of some hours, a maximum tension which remains constant so long as the temperature is invariable. This maximum tension increases rapidly with the temperature.

On Cerium Molybdate.—Alph. Cossa.—With reference to M. Didier's note on the tungstates and chlorotungstates of cerium the author states that the form of the crystals of cerium tungstate which he prepared in 1880 was studied by Q. Sella in the same year, but the measurements proving the isomorphism of this cerium salt with Scheelite remained unpublished until 1885. In 1884 he obtained cerium molybdate in octahedral crystals, isomorphous with wulfenite.

New Alloy of Aluminium.—M. Bourbouze.—The author recommends an alloy of aluminium and tin for all instruments which require lightness. Its specific gravity is 2·85; it can be soldered as easily as brass without any special preparation, and it resists most reagents as well as aluminium.

Presence of Cholesterin in the Carrot.—A. Arnaud.—Husemann's hydrocarotine is in reality vegetable cholesterin, though in an impure condition.

Researches on the Development of the Beet-Root.—Aimé Girard.—This paper does not admit of useful abstraction.

Presence of Cholesterin in certain New Fatty Bodies of Vegetable Origin.—Ed. Heckel and Fr. Schlagdenhauffen.—The authors recognise cholesterin in the oils extrained from the seeds of chaulmoogra, of

bonduc, of jequirity, and in the mixture of fats and waxes extracted from the leaves of *Erythroxylum hypericifolium*.

Crystalline Form of the Sodium Pyrophosphates and Hypophosphates.—H. Dufet.—The sodium salts of these acids have the peculiarity that those containing the same number of mols. of soda contain also the same number of mols. of crystalline water.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Part 9.

Contributions to the Chemistry of Sea-Water.—(Parts II., III., and IV.)—A. Hamberg.—Part II. of this memoir treats of apparatus for determining nitrogen and carbon dioxide in sea-water and cannot be reproduced without the two accompanying plates. In Part III. the author refers to the old opinion of enormous proportions of gases present in the depths of the sea, and notices the discrepancies in the results obtained by Tornöe and by Dittmar in sea-water, and by Bunsen and Dittmar in fresh water. In sea-water Tornöe found the absorption-coefficient for nitrogen gas 14·40, and Dittmar 15·60. In fresh water Bunsen finds it 20·35 and Dittmar 24·40. For fresh water the author's own results agree fairly well with those of Dittmar, whilst Bunsen's coefficient of absorption appears too low. But for sea-water the author's determinations agree much better with those of Tornöe than with those of Dittmar. In Part IV. the author criticises the results and conclusions of Jacobsen, Buchanan, Tornöe, Schlœsing, and Dittmar on the presence of carbonic acid in sea-water and the manner of its retention. He then shows the importance of the influence of temperature upon the proportion of carbonic acid. A difference of 10° in the temperature represents a difference of 3 to 6 per cent in the carbonic acid. He considers that in every determination the same precautions must be observed as in determinations of the air. Up to the present date there are no trustworthy determinations of the carbonic acid in sea-water.

Calorimetric Researches.—F. Stohmann, P. Rodatz, and H. Herzberg.—The authors determine the thermic value of the oxybenzols and the thermic value of the hydroxyl-groups contained in the oxybenzols.

New Apparatus for Electro-chemical Researches.—N. von Klobukow.—This paper cannot be intelligibly reproduced without the accompanying plate.

On Thiopheniferous Benzol.—C. Willgerodt. The author eliminates thiophene by passing into the retort containing the benzol chlorine gas. The retort is protected from light and cooled with ice.

The Clays of Heinstädt.—C. W. Blomstrand.—In Part 3, p. 132, of this Journal (also Chemical News, vol. liii., p. 136), was a paper by Dr. Strohecker on "Cerium Oxides, Yttria, Glucina, and Ammonium Chloride in Diluvial Clays." The author points out many questionable statements in this paper, especially as far as the analytical methods are concerned, and, pending further evidence, regards with some scepticism the existence of clays containing 18 per cent of rare earths.

Bulletin de la Société Chimique de Paris.
Vol. xlv., May 15, 1886.

This issue consists entirely of extracts from other journals.

No. 10, May 20, 1886.

Variations of Solubility of certain Chlorides in presence of Hydrochloric Acid.—R. Engel.—The author has determined the variations undergone by the solubility in water at 0° of various metallic chlorides under the influence of increasing quantities of hydrochloric acid. He deduces the approximate law that the solubility of the chlorides which hydrochloric acid precipitates from their aqueous solution diminishes in presence of this acid by a quantity corresponding sensibly to an equivalent of chloride for each equivalent of hydrochloric acid. He adds that this law is true only in as far as the solubility of the chloride in the acid liquid has not diminished by more than three-fourths of its solubility in pure water.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Toughening Paper.—Can any of your readers inform me in which paper or periodical the following appeared? I should be obliged for any information which would enable me to get further particulars apout it.—J. E. P.

"*Toughening Paper.*—A plan for rendering paper as tough as wood or leather has been recently introduced on the Continent. It consists in mixing zinc chloride with the pulp in course of manufacture. The greater the degree of concentration of the zinc solution the greater will be the toughness of the paper."

MEETINGS FOR THE WEEK.

Wednesday, 30th.—Society of Arts, 4. (Anniversary).
Friday, July 2nd.—Geologists' Association, 8.

TO CORRESPONDENTS.

J. R.—Information asked for in our "Notes and Queries" column should be given for the benefit of all readers of the Chemical News.

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2. On Candle Manufacture and the Treatment of the By-Products. Four Lectures by Leopold Field, F.R.S.E., on July 5th, 6th, 8th, and 9th, at 7.30 p.m. each day. Fee 5s.
3. On the Chemistry of Tanning. Four Lectures, with experimental illustrations, by Henry R. Procter, F.C.S., on July 12th, 13th, 15th, and 16th, at 7.30 p.m. Fee 5s.
4. On the Technology of Cellulose and Paper Manufacture. Four Lectures by C. F. Cross, Esq., F.C.S., assisted by E. T. Bevan, Esq., F.C.S., on July 19th, 20th, 22nd, and 23rd, at 7.30 p.m. Fee 5s.
5. On Building Materials. Four Lectures by W. G. Dent, F.C.S., F.I.C., on July 26th, 27th, 29th, and 30th, at 7.30 p.m. Fee 5s.

Further particulars and Syllabus of each Course may be obtained at the Central Institution, Exhibition Road, S.W., or at Gresham College, London, E.C.

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PHILIP MAGNUS.
Director and Secretary.

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NOTE ON A METHOD OF ILLUSTRATING THE PERIODIC LAW.

By J. EMERSON REYNOLDS, M.D., F.R.S.
Professor of Chemistry, University of Dublin.

THE annexed woodcut is a reproduction of a diagram which has been used in my lecture-room for some years in order to illustrate the periodic character of the relation between the atomic weights and properties of the chemical elements. It was not intended for publication, but some scientific friends considered it likely to prove useful and suggestive outside the limits of a University theatre: hence this note.

The curve represented is intended to give a special picture of the general relations of the elements, and its foundation is Mendeleeff's well-known tabular classification in which he applies and greatly extends the important periodic principle recognised by Newland.

Every chemist is familiar with the annexed table, but it is given to save the trouble of reference elsewhere.

The details of this classification are so well known through the numerous and important papers of Dr. Carnelley and others that it is unnecessary to discuss them here. It will suffice to point out that the chief features are—

1st. The arrangement of the elements according to atomic weight in twelve "series," or "periods" of seven (or in some cases ten) members each. These are found on the same horizontal line.

2nd. The division of the elements which occupy similar positions in the respective periods into "groups" of analogous bodies. These are found in the same vertical column, and there are eight such groups, as the exceptional members of Mendeleeff's "long" or ten-member periods form the eighth group.

3rd. The distinction of the periods into two classes, "odd" and "even," since the corresponding members of *alternate* periods are found to resemble each other more closely than those they immediately succeed or precede.

When we carefully consider the relations of the members of the "periods" it is found that the general properties of the elements vary from one to another with tolerable regularity until the seventh member is reached, which latter is in more or less direct *contrast* with the first element of the same period, and with that of the next. Thus chlorine—which is the seventh member of Mendeleeff's third period—is in chemical contrast with sodium, the first member of the same series, and also with potassium, which is the first member of the next series. On the other hand, sodium and potassium are analogous forms of matter. Now the six elements whose atomic weights lie between those of sodium and potassium vary in properties from one member to another until the sodium contrast—chlorine—is reached; but from chlorine to the sodium analogue—potassium—the change in properties appears to take place *per saltum*. Similar alternations of gradual and abrupt changes in properties are observed as the atomic weights increase.

The real distinction just pointed out seems to have attracted singularly little attention in the construction of the curves or spirals which are intended to illustrate the relations of the elements in accordance with the periodic principle, yet its recognition is essential if we are to form an adequate mental picture of the relations in question: the particular direction it gives to our conceptions will presently appear.

If the relations of the elements within each period are now considered with a view to graphic translation, it is evident that the recognition of more or less contrast in properties between the first and last members of each series implies the existence of a position of mean variation or transition within each system.

On further comparing the members of the periods, it is found that the *fourth* element of each series in general possesses the properties which a transition member might be expected to exhibit. Thus silicon may be represented at the apex of a tolerably symmetrical curve which should represent for the particular period the direction in which the properties of the series of elements vary with rising atomic weight.

A physical analogy will help to make the meaning of this clear:—

Let the line A B (Fig. 1.) represent part of a string in tension, and a, b, c, d, e, f, and g seven knots upon it. The string is now thrown into a number of vibrating segments: o and o' represent two nodal points, between which one segmental vibration takes place. The several knots oscillate rapidly to and fro in the direction of the dotted lines, a moving from the position of rest to a' and back again, when it swings to the same extent on the opposite side of the line A B, returns, and starts afresh. Each knot performs similar journeys, but the lengths of the paths vary: thus the length increases from a to b, from b to c, and from c to d, while it diminishes from d to e, e to f, and f to g. The knot d is therefore exceptional, in that it suffers the maximum displacement from the mean position; the knots c and e perform journeys of comparable lengths, but they are otherwise in more or less direct contrast; similarly b and f, a and g, form contrasted pairs.

Let the knots in the string represent the atomic groupings we call elements, arranged in the order of

Series or Period.	Group I. R_2O	Group II. RO	Group III. R_2O_3	Group IV. RH_4 RO_2	Group V. RH_3 R_2O_5	Group VI. RH_2 RO_3	Group VII. RH R_2O_7	Group VIII. RO_4
1	H=1							
2	Li=7	Be=9	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27	Si=28	P=31	S=32	Cl=35·5	
4	K=39	Ca=40	Sc=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Ni=58·5, Co=59
5	Cu=63	Zn=65	Ga=69	—=72	As=75	Se=79	Br=80	
6	Rb=85	Sr=87	Y=89	Zr=90	Nb=94	Mo=96	—=100	Rh=104, Ru=104·5 Pd=106
7	Ag=108	Cd=112	In=113	Sn=118	Sb=121	Te=125	I=127	
8	Cs=133	Ba=137	La=139	Ce=141	Di=144	,	—	—
9	(—)	—	—	—	Er=166	—	—	—
10	—	—	—	—	Ta=182	W=184	—	Ir=192·5, Os=193 Pt=194·5
11	Au=196	Hg=200	Tl=204	Pb=207	Bi=208	—	—	—
12	—	—	—	Th=233	—	U=240	—	—

atomic weight* rising from *a* to *g*, and we have a picture of a "period" of seven elements regarded as a vibrating system. Unlike most analogies, this one bears tolerably close examination.

Thus, if we take any well-defined periods, such as the two following,—

2.—Li=7, Be=9, B=11, C=12, N=14, O=16, F=19
3.—Na=23, Mg=24, Al=27, Si=28, P=31, S=32, Cl=35·5

we find that the *fourth* member naturally divides the particular period in two parts. In the period 2 carbon is the middle term, and in 3 silicon. Corresponding elements to these can be found in nearly all the succeeding periods, and their properties in relation to those of the membe of the same period which immediately precede and follo them are on the whole exceptional. They afford strong marked dioxides whose hydrates exhibit very feeble a properties, and in all the best known periods they appe as transition elements between two sub-groups of thr each. I propose to distinguish such bodies as *me elements* to avoid needless repetition. Now the mes element of a period is analogous to the knot *d* when at i maximum displacement.

If we examine a particular period—for instance, th one whose meso-element is silicon—we note:—*Fir* that the three elements of lower atomic weight th silicon, viz., sodium, magnesium, and aluminium, a distinctly *electro-positive* in character, while those higher atomic weight, viz., phosphorus, sulphur, a chlorine, are as distinctly *electro-negative*. Throughou the best-known periods this remarkable subdivision is o servable, although, as might be anticipated, the differenc become less strongly marked as the atomic weights i crease. *Secondly*, that the members above and below th meso-element fall into pairs of elements, which, whi exhibiting certain analogies, are generally in more or le direct chemical contrast. Thus, in the silicon period w have—

Si iv

+Al‴	P‴ –
+Mg″	S″ –
+Na′	Cl′ –

This division also happens, in many cases, to coinci with some characteristic valence* of the contrasted el ments. It is noteworthy, however, that the members o the electro-negative side exhibit the most marked tendenc to variation in atom-fixing power, so that valence alone an untrustworthy guide to the probable position of a element in a period.

The pairs of more or less contrasted elements may l likened to the pairs of knots on the string whose pat of vibration are of approximately equal length; but it convenient for the purpose of graphic illustration assume that the paths of each pair are of the same leng or that the displacements are in the ratio of 1:2:3:4 that of *d*′, Fig. 1, which is the longest. On reference the diagram, Fig. 2, the nature of this arrangement w be evident, and the portions when connected as shown are seen to form an expanding curve such as would afforded by a string or chain† whose parts are in unequ tension. With the aid of the scale A B there is no dif culty in picturing the elements in the positions of th knots on the string, and so regarding them as members a vibrating system. All the elements whose constan are well known find places on the curve.‡

Thus the physical analogy helps us to form some co ception of the relations of the members of the period and of the latter to one another. Moreover, the adm sion of the periodic principle at all seems to require t recognition of similar relations to those indicated.

It will now be interesting to note some of the poi suggested by the foregoing considerations:—

1. If we picture the elements as members of some sy vibrating system as supposed, difficulties of th kind noted in the case of the relations of chlori to potassium disappear, since the potassium knot in a complementary position to that of chlorin and is in a certain sense in direct contrast
2. On Mendeleeff's system hydrogen is the solitary r presentative of his first period, and it seems to ha

* Of course this arrangement is not necessarily symmetrical, as supposed in the case of the knotted string.

* This term is here used in the wide sense in which it was em ployed by Wurtz.

† My friend Prof. Fitzgerald, F.R.S., suggests that a vibrating m tallic chain, suspended from the ceiling and attached to the dr would afford a more complete picture, as the regular and considerab changes of tension, due to the increasing weight, would lead to t production of regularly expanding loops.

‡ The length of the page of the CHEMICAL NEWS prevents th representation of thorium (233) and uranium (240), but they fall n turally into position on an extension of the curve.

Fig. 1.

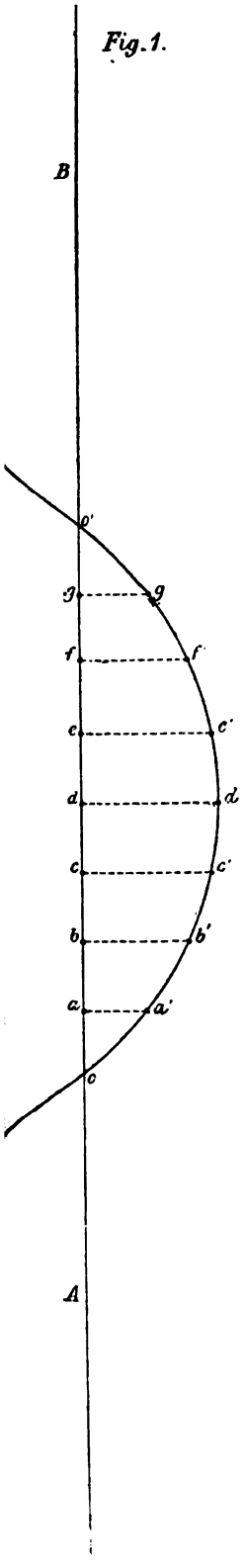
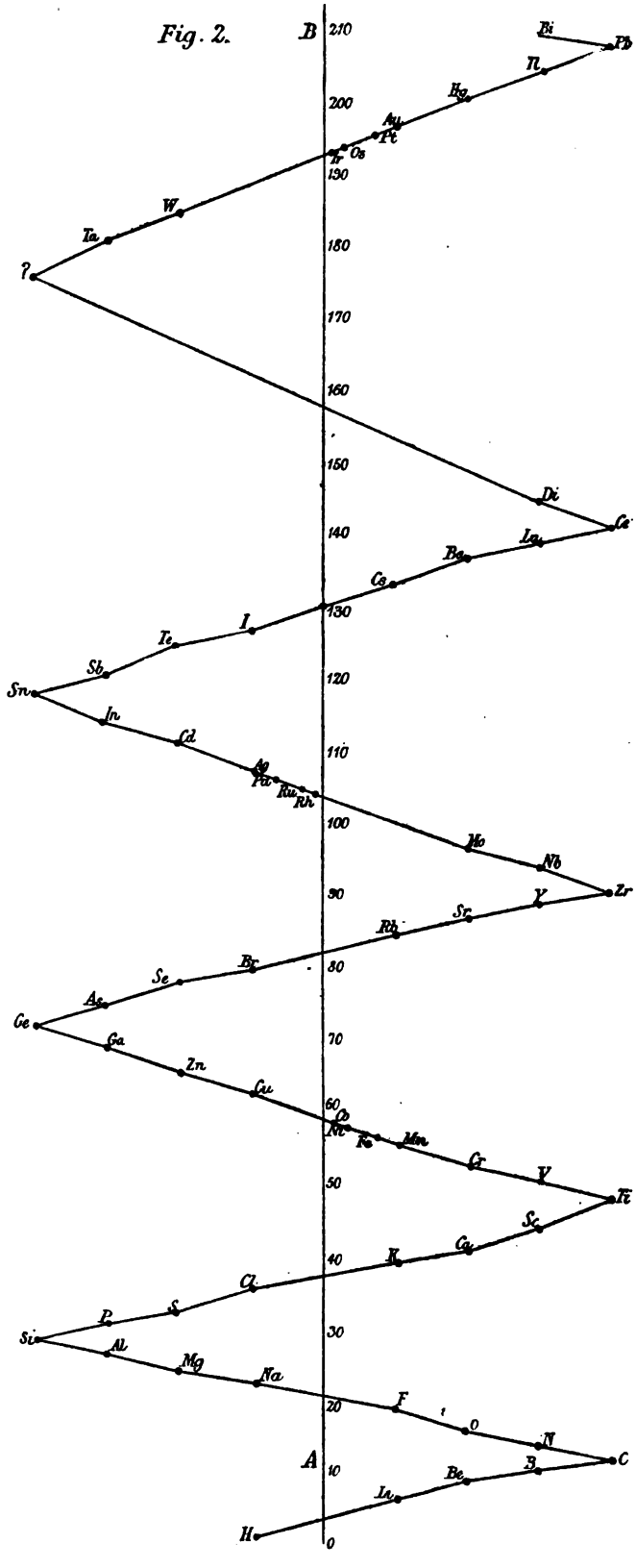

B
A
a'
b'
c'
d
c'
d
c'
f'
g
g'
f
e
d
c
b
a
a'
b'
c'
d'
e'
f'
g'

Fig. 2.


B
A
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Bi
Pb
Tl
Hg
Au
Pt
Ir
Os
W
Ta
?
Di
Ce
La
Ba
Cs
I
Te
Sb
Sn
In
Cd
Ag
Pd
Ru
Rh
Mo
Nb
Zr
Y
Sr
Rb
Br
Se
As
Ge
Ga
Zn
Cu
Ni
Co
Fe
Mn
Cr
V
Ti
Sc
Ca
K
Cl
S
P
Si
Al
Mg
Na
F
O
N
C
B
Be
Li
H

been assumed that the other six members (hypothetical) must have atomic weights between 1 and 7. If, however, we allow the form of the curve to influence our judgment, the position of hydrogen in reference to lithium is rather that of the *last* member of one period to the first of another. Hence, if hydrogen is really a member of a period of seven elements, and the seventh member, the remaining six must have atomic weights less than that of hydrogen. There is therefore room for Lockyer's "helium," and for the element that Dumas' modification of Prout's law demands.

3. The "odd" and "even" periods of Mendeleeff are at once distinguished: thus, while the knots representing the carbon period are at the extreme limit on one side of the mean position A B, those of the silicon period are necessarily at corresponding points on the *opposite* side. The strictly analogous periods are thererefore found on the *same* side of the line A B, and elements found at *similar points* on the curve should form a homologous series. For example: Mg, Zn, and Cd are members of such a series on one side, while Ca, Sr, and Ba form a similar group on the other; the two groups of homologues exhibiting, at the same time, the many cross relations we should expect.
4. The general contour of the curve is such that we are not permitted to assume the existence of Mendeleeff's *ninth* period (see table *supra*). This is remarkable, as six out of these seven elements postulated by Mendeleeff are admittedly unknown, while the single known element supposed to belong to the period is erbium. Now, even if the atomic weight of erbium be 166, as supposed, it is obviously possible to find a place for the element in the period which includes tantalum and tungsten, so that it is not necessary to assume the existence of a whole period in order to find a place for erbium. But it is doubtful whether the constants of the *pure* element are yet sufficiently known to justify a decision between the two points that can be selected for it.
5. As the eye traces the curve from hydrogen upwards it is seen that near to *three* out of the ten nodal points the symbols of the elements which form Mendeleeff's "eighth group" are to be found. These bodies are obviously *interperiodic*, in the sense that their atomic weights necessarily exclude them from the periods into which the other elements fall, while their chemical relations with certain members of the adjacent periods lead to the conclusion that they are interperiodic in the special sense of being transitional as well.

This "group," so-called, is divisible into three triplets, which are as follow:—

First.	Second.	Third.
Iron = 56.	Rhodium = 104.	Iridium = 192·5.
Nickel = 58·5	Ruthenium = 104·5.	Osmium = 193.
Cobalt = 59.	Palladium = 106.	Platinum = 194·5.

Each triplet seems to form a small period of very closely related elements. It is well known that the members of each triplet so closely approach in atomic weight, present so many physical and chemical characters in common, and are so frequently associated in Nature, that they have often been regarded as probable modifications of a single form of matter. Again, all nine members have low atomic volumes (between 6 and 10), resembling in this respect most of the meso-elements, with which latter, however, they present few other points of similarity. When the scale positions of the triplets are considered they are seen to occur at three points where the known adjacent members of the periods which form the general system exhibit feeble electro chemical contrasts—thus, between manganese and copper, the iron triplet appears, between molybdenum and silver the palladium triplet, and between tungsten and gold the platinum triplet. At the corresponding points where the electro-chemical contrasts are very marked—between fluorine and sodium or chlorine and potassium—interperiodic triplets are unknown.

Notwithstanding the exclusion of Mendeleeff's ninth period the diagram shows that a considerable number of elements are still required to complete the system. Doubtless the rare earth metals, when thoroughly identified, will be found to fill some of the vacancies in the periods, just as the new element, germanium, seems to possess most of the properties, predicted by Mendeleeff, of the hypothetical ekasilicon. The discovery of a principle which renders successful prediction possible, as in the cases of gallium, scandium, and germanium, marks a great advance in science, and it is hoped that the mode of picturing the relations of the elements pointed out in this note may facilitate the recognition and application of the principle.

ON THE

ATOMIC WEIGHT AND THE SPECTRUM OF GERMANIUM.

By M. LECOQ DE BOISBRAUDRAN.

THE author has just received from Prof. Cl. Winkler, of Freyberg, a fine specimen of germanium. Prof. Winkler was at first inclined to place this body between bismuth and antimony, but he now considers that it should rank between silicon and tin, as the "eka-silicium" in Prof. Mendeleeff's classification. This opinion rests on various important properties of the new metal and on its atomic weight, provisionally fixed at 74·75. M. de Boisbaudran does not undertake to describe this new element which Prof. Winkler is actively studying, but he thinks it may not be uninteresting to give certain observations which confirm M. Winkler's more recent opinion as to the position of germanium in the classification of the elementary bodies.

Long ago, and even before the researches of M. Mendeleeff on this subject, the author had calculated the atomic weight of the hypothetical body intermediate between silicon and tin by means of a classification which has not been published, but which he has often discussed with the regretted J. B. Dumas. He found it 72·28, taking Si = 28 and Sn = 118; M. Mendeleeff gives it as 72 in his table. It is here added in a note that Mr. Newlands had also foreseen the existence of a new element in the series carbon-silicon, and had assigned to it the atomic weight 73.

The author has submitted germanium to the action of the induction spark. There is produced a very fine spectrum which he has not yet had time to examine completely, but which contains two rays of remarkable brightness, a blue and a violet. He has measured these rays with a degree of exactness sufficient for applying his formulæ connecting the wave-lengths of homologous rays and the atomic weights of the bodies which produce them. He has searched for the atomic weight of germanium by this spectroscopic procedure, supposing the element intermediate between silicon and tin.

The homology of the rays is thus established:—

Si.	Gr.	Sn.
1st ray, λ = 412·9	1st ray, λ = 468·0	1st ray, λ = 563·0
2nd ,, 389·0	2nd ,, 422·6	2nd ,, 452·4
Mean 401·0	Mean 445·3	Mean 5077

If we take as a term of comparison the known series Al—Ga—In we have—

Atomic weights.		Differences.	Variations.	Mean wave-lengths (Two rays).		Differences.	Variations.
Si	28·0	90·0		Si	401·0		
Gr	? between Si and Sn					44·3	$\frac{40·51}{100}$
				Gr	445·3		
Sn	118·0					62·4	
				Sn	507·7		
Al	27·5						
		42·4	$\frac{2·8302}{100}$	Al	395·2		
Ga	69·9					14·9	$\frac{37·584}{100}$
		43·6		Ga	410·1		
In	113·5					20·5	
				In	430·6		

(That is to say 2·8302 per cent must be added to the difference 42·4 to obtain the difference 43·6).

The variation of the increase of the atomic weights is, erefore, 0·028302 in the series Al—Ga—In; the varia-on of the increase of the wave-lengths is 0·4051 for —Gr—Sn and 0·37584 for Al—Ga—In. Following e law which the author has formerly applied to the lculation of the atomic weight of gallium, and which is at in the several natural families the variation of the crease of the atomic weights is proportional to the crease of the wave-lengths of the homologous rays r groups of rays), taken in what he calls the third rmonic of the spectra. Following this law we have ly to put—

-Ga—In λ.	Al—Ga—In At. wt.	Si—Gr—Sn λ.	
37·584 :	2·8302 : :	40·51 :	x = the variation of the increase of the atomic weights in the series Si—Gr—Sn.

e find x = 3·051 per cent.

The increase of the atomic weight from Si to Gr is erefore—

$$\frac{90}{2·03051} = 44·32$$

hence the series—

Si	28·00
	44·32
Gr..	72·32
	45·68
Sn	118·00

It will be seen that the number 72·32 agrees well with at, 72·28, which the author had previously deduced from classification alone. But, on account of the slight un-tainty which exists on the subject of the ray 389 of icon, we will repeat the same calculation with a single for each metal, thus avoiding the use of Si 389, and ing two decimal places to the measurements of λ. We have then—

Atomic weights.	Wave-lengths. (A single ray, the less refrangible of the two).		Diffs.	Variations.
above, with a	Si ..	412·89		
ingle decimal,			55·15	$\frac{72·185}{100}$
on account of	Gr ..	468·04		
the uncertainty			94·96	
of the determi-	Sn ..	563·00		
minations.				
	Al ..	396·10		
			20·95	$\frac{61·814}{100}$
	Ga ..	417·05		
			33·90	
	In ..	450·95		

itting—

-Ga—In λ.	Al—Ga—In At. wts.	Si—Gr—Sn λ.	
61·814 :	2·8302 : :	72·185 :	x = the variation of the increase of the atomic weights in the series Si—Gr—Sn.

We find x = 3055 per cent. The increase of the atomic weight from Si to Gr is therefore—

$$\frac{90}{2·033055} = 44·2684, \text{ say } 44·27$$

Whence the series—

Si	28·00
	44·27
Gr..	72·27
	45·73
Sn..	118·00

There is thus a very satisfactory agreement been the previsions of the classification, giving 72·28, and the result of the calculation by the best rays, which is 72·27.

A similar exactness was obtained for gallium previous to any possible determination by the balance.

The classification gave	69·82
Calculation for the rays	69·86
Subsequent gravimetric determination (mean)	69·87

M. Mendeleeff's table assigned the atomic weight 68 to the body situate between Al and In. The difference between the figures of M. Mendeleeff and those of the author is much greater for eka-aluminium than for eka-silicium.

The atomic weights deduced, whether from classification alone or from the calculation of the wave-lengths, depend naturally on the atomic weights or on the wave-lengths and the atomic weights which may be affected by slight errors; it is clear that corrections in the numbers which have served as the bases of these calculations will involve corresponding corrections in the author's theoretic weights. Still these errors ought not to be important, since both for gallium and germanium there is a satisfactory agreement between the data of the author's classification and the results of the application of his special rule.

It will be interesting to see if Professor Winkler will confirm his atomic weight 72·75, or if he will find it approaching 72·3 with a very thoroughly purified specimen.

If germanium has really the atomic weight 72·75, shall we not be warranted in suspecting the accuracy of the atomic weights Si = 28·0 and Sn = 118·0? — *Comptes Rendus*, vol. cii., No. 23, p. 1291.

NOTES ON THE

SOLUBILITY OF THE PHOSPHORIC ACID CONTAINED IN THOMAS SLAG.

By JOSEPH FLETCHER, F.C.S., M.R.I.A.,
Fellow of the Chemical Societies of Berlin and Paris, and Abstractor to *Chemical Society's Journal*.

YOUR columns have, quite recently, contained a notice of certain experiments on the agricultural value of Thomas slag. The subject has attracted much greater attention in Germany than in this country, and has been experimented on at several of the official agricultural stations.

An excellent *resumé* of what has been done up to the present will be found in *Biedermann's Centralblatt*, vol. xiv., pp. 738 to 756, condensed by Dr. Moritz Fleischer.

The slag when removed from the converters is in pieces of irregular size; exposed to the atmosphere it slowly falls into smaller fragments, emitting the smell of sulphuretted hydrogen. For agricultural purposes it requires to be finely ground,—at least so finely as to pass through a sieve 20 meshes to the inch; it is then a blackish brown powder, containing numerous tabular crystals. Dr. Fleischer thinks that the slag will be found useful as an addition to other manures, but at present he cannot recommend its use alone.

The experiments made with various crops and different mixtures of manures will more properly be the subject of a communication to an agricultural journal; but as its value as a manure will depend on the facility with which the phosphoric acid it contains becomes assimilable in the soil, the experiments reported in this paper were made.

Slag from different localities varies considerably in composition, as will be seen from the following analyses, No. 1 being the average of a number of German samples examined by Fleischer and Hasenclever, and No. 2 a slag from rolling-mills at Willkowitz, in Austrian Silesia:—

	No. 1.	No. 2.
Phosphoric acid	17·5	18·06
Lime..	49·6	34·14
Magnesia..	4·7	6·26
Ferrous oxide	9·3	23·70
Ferric oxide	4·1	
Alumina	2·0	10·13
Manganese oxide	4·0	0·79
Sulphur, free	0·5	trace
Sulphuric acid	0·2	none
Silicic acid	7·5	3·69

The differences are due doubtless to the description of ores worked and the composition of the basic lining of the converters.

The sample employed by the writer was obtained from Birmingham, and finely ground (for 20-mesh sieve). For each experiment 10 grms. were taken, 100 c.c. of the solvent added, left for two hours, diluted to a litre, the P_2O_5 precipitated by molybdate; precipitate re-dissolved, and estimated as pyrophosphate. The sample contained total phosphoric acid 18·658 per cent = 40·732 per cent $(Ca_3PO_4)_2$.

No.	Solvent.	Per cents dissolved. P_2O_5	$= Ca_3(PO_4)_2$.
1.	Tap water	1·469	3·206
2.	Peat water..	2·236	4·882
3.	Normal sodium carbonate ..	2·556	5·579
4.	Normal sol. acetic acid	4·217	9·19
5.	Joulie's formula (ammonium citrate)	6·39	13·949
6.	Ammonium oxalate	11·5	25·104

No. 1.—Tap water was the ordinary Dublin supply, derived from a peaty source, but filtered moderately well.

No. 2 was a decoction obtained by boiling 10 grms. of air-dried peat for one hour, and diluting to 1 litre.

Nos. 3 and 4.—Ordinary normal solutions as used in volumetric analysis.

No. 5 was treated exactly according to the recent directions of Joulie, the solutions having been carefully prepared of correct strength.

No. 6.—In this case the solution was saturated, and the sample boiled in it. The solution was originally intended to test Joulie's theories on the classification of raw phosphates, as given in his book "Engrais Chimiques."

Experiment No. 2 scarcely gives a fair idea of the effects which humus, humic acid, crenic and apocrenic acids, so called, would exercise on an easily decomposable compound subject to their influence for a long period.

Experiment No. 3 is also a very feeble indication of the effect of large quantities of free carbonic acid for long periods such as are contained in all arable soils. To give a fair idea of this the sample should be subjected for a considerable time to the action of water charged with free carbonic acid.

Experiment No. 4 is very suggestive, probably the most so of the series, in view of the recent investigations on the action of micro-organisms in the soil, and their office of promoting acetic and butyric fermentations therein.

Experiment No. 5 is not less suggestive: the action of citric acid is very decisive. It may be found hereafter that some, perhaps many, of the organic acids of the soil approach in their nature and action citric and tartaric acids.

Of the chemical constitution of those organic compounds, their changes, and the part they play in rendering inorganic substances available for the sustenance of plants, we know little, notwithstanding the great names associated with the subject; still less do we know of the part played by those micro-organisms which recent observations have proved important factors in Nature's operations.

I hope to continue and to amplify those experiments; but, as far as they go, I think they reasonably lead to the opinion that the phosphoric acid in the slag exists in such a state that, when brought into contact with those organic matters, dissociation takes place, and it is rendered easily assimilable by the plants.

I have to thank my young friend Mr. F. J. Richardson for his able assistance in carrying out the experiments.

Laboratory Chemical Manure Works,
Ringsend Docks, Dublin.

ON THE

ERROR IN THE NITROMETRIC ASSAY OF VITRIOL.

By THOMAS BAYLEY.

Prof. Lunge asserts (Chemical News, vol. liii., p. 289) that no error can possibly arise in the nitrometric assay of vitriol, from the presence of iron, since only proto-salts dissolve nitric oxide, and proto-salt cannot exist in presence of nitrous or nitric acid. He also regrets that, before ascribing any such action to iron, I did not try an experiment with nitrous vitriol containing it.

Of course Prof. Lunge is quite correct in saying that only proto-salts of iron form the dark compound with nitric oxide, but, in spite of that, ferric salts contained in vitriol do lead to the absorption of nitric oxide in the nitrometer. If a few drops of a solution of ferric nitrate be mixed in the instrument with pure sulphuric acid the dark colour is obtained, not immediately, but after shaking for a minute or so. And after the experiment the liquid, which previously showed no ferrous reaction, gives a blue colouration with dilute solution of ferricyanide of potassium. Therefore, in contact with mercury and nitric acid, ferric salts are reduced, and it will be interesting to observe whether a similar reaction takes place with other salts than the nitrate.

I have previously stated that "*pur*"—that is, *purified*—sulphuric acid, of the shops, obtained in this neighbourhood, frequently (indeed almost always) gives a colouration with nitre in the nitrometer; but it may or may not be so in other districts, according to the method of purification employed. Having frequently to estimate small fractions of a grain of copper, iron, and other metals per lb. in metallic lead, I have learned not to rely upon the purity of this "*pur*" acid. Acid made from English pyrites from the

coal-measures, containing traces only of copper, is not free from that metal, and requires to be purified for special purposes. Probably the acid gets the copper from the chamber lead, and some at least of the iron in the same way. This acid made from English pyrites is comparatively very free from arsenic, but contains, before rectification, much organic matter. I have found it give the colour reaction of NO and iron (pink to reddish tints) many dozens of times, and cannot understand how Prof. Lunge can have failed to notice this colour when testing his method for impure nitrous vitriol. The matter is still under investigation in my laboratory with a view of finding a way of avoiding the error introduced by iron. I have tried introducing chromate and other oxidising solutions after the shaking, but without the effect of freeing the dissolved gas. But for an oversight a statement of the reaction of mercury upon iron salts would have been contained in my last paper.

With so courteous an opponent as Prof. Lunge I cannot conclude without expressing regret if I have done him an injustice in ascribing the invention of the nitrometer to Davis, who (according to Allen, *J. Chem. Ind.*, March, 1885) claims to have used a similar instrument prior to March, 1878.

The late Mr. Edward Jackson designed a somewhat modified nitrometer, which has the advantage of almost entirely preventing frothing, and of causing rapid separation of the acid and mercury. This instrument is peculiar only in the shape of the graduated tube, which is wide, ¾ to 1 inch, and tapers gradually to the tap. The appearance of a tint due to iron is indicated at once with this instrument, the clearing of the acid being very rapid.

Birmingham, June 21, 1886.

CERIUM IN THE HAINSTADT CLAYS.

EXPLANATION.

By Dr. J. R. STROHACKER.

THE *Journal für Praktische Chemie* (No. 9, 1886),* contains an article on the question of the Hainstadt Clays which transgresses the limits of discussion recognised in Europe, and the purport of which is nothing less than that of chemical research, but simply insult. I declare, therefore, hereby, that I maintain point for point my statements in my two memoirs (pp. 132 and 260 of this volume of the *Journal für Prakt. Chemie*), as my analyses were conducted quite carefully.

To meet the points specially raised I remark the following facts:—

1. If the flesh-coloured Hainstadt Clay No. I., in very fine powder is introduced into a concentrated solution of alkali and strongly boiled for two days in a covered iron vessel, all the cerium hydroxide present is dissolved out along with Al_2O_3 and SiO_2; Ce_3O_4 is obtained from the solution in the manner described.

2. We may be easily convinced of the solubility of cerium hydroxide in caustic alkali by boiling the precipitate obtained from the hydrochloric extracts of clay No. I. with caustic alkali.

3. Cerium sal-ammoniac, a salt which has long been known, is formed in the nascent state on introducing NH_3 into a solution of Ce_2Cl_6 containing an excess of acid.

4. The pale yellow ferrocyanide solution of Ce_2O_3 obtained from a neutral solution (which I regarded at first as a secondary matter), if the liquid is previously acidulated, takes a blue colour on heating, as the oxidising action of Ce_2O_3 upon hydro-ferrocyanic acid precipitates Prussian blue. This was formerly not observed.

5. The Hainstadt cerium hydroxide has, when freshly precipitated, the greatest resemblance to iron hydroxide. When dried and powdered, however, it forms an orange yellow—not red-brown—powder. Ce_2O_3, anhydrous, is a very bright orange-red, whilst Fe_2O_3, anhydrous, is a blood-red (colcothar). The cerium hydroxide is therefore very distinct from ferric oxide.

6. If, subsequently, a difference is discovered between the Hainstadt and the Swedish cerium, I cannot decide, but it cannot be regarded as Fe, the oxide of which cannot be extracted by caustic alkali.

7. I have extracted the black clay No. II.*a* never with alkali, but always with HCl, and have always found in it Ce, La, Yt, and in two cases Di; Be, it may be here remarked, is not rare in the minerals of the Odenwald, since the beryl itself is well known to occur in the granites of the district.

8. During the last half year I have obtained from the Hainstadt clays considerable quantities of the salts of lanthanum and yttrium.

9. Other results of eminent analysts have beeen already announced.

(Signed) Dr. J. R. STROHACKER.

Frankfort-on-the-Main.
June 16, 1886.

* Also reprinted in the CHEMICAL NEWS, vol. liii., p. 136.

MINOR INVESTIGATIONS.

By L. M. NORTON.

I. *Oxidation of Benzol.*

THE action of a powerful oxidising agent upon benzol has been occasionally investigated, but the unexpected results obtained in certain cases have hardly attracted the attention they deserve. The formation of benzoic acid by the oxidation of benzol is certainly worthy of notice. Under my direction Mr. J. G. Holder has repeated some previous experiments in this direction, and we have also attempted the oxidation of benzol by some methods not heretofore employed. I give a summary of our experiments. The benzol used in all the experiments boiled between 80·2° and 80·3°, and left no residue at the latter temperature. Our analysis gave figures which corresponded to 92·20 per cent of carbon and 7·70 per cent of hydrogen, while the theory requires 92·30 per cent of carbon and 7·70 per cent of hydrogen. Its perfect freedom from toluol is certain, as long-continued boiling with dilute nitric acid and also with a solution of chromic acid in acetic acid failed to furnish the least trace of benzoic acid. Carius† first investigated the action of binoxide of manganese and sulphuric acid upon benzol and obtained carbonic anhydride, formic acid, benzoic acid, and a phthalic acid. We investigated this method of oxidation under somewhat different conditions with a somewhat different result. Three large flasks were taken and 100 grms. of benzol placed in each. The benzol was carefully cooled, and a mixture of 600 grms. of ordinary pure sulphuric acid and 120 grms. of water slowly added to each flask, all heating being carefully avoided. Next, 100 grms. of powdered MnO_2 were stirred into the mixture in each flask and the mixture then allowed to stand one week, with frequent stirring. The undecomposed benzol was then removed by distillation, the acid nearly neutralised with caustic soda, and evaporated to a small volume, and this liquid treated with ether, which removed an organic acid from the liquid. This acid was then purified. It sublimed without decomposition, agreed in all physical properties with benzoic acid, and furnished barium and calcium salts, which, upon analysis, proved to be the benzoates of barium and calcium. The yield of benzoic acid is small. Carbonic anhydride was the other product of the oxidation which we observed. We were unable to convince ourselves of the presence of formic or phthalic acids.

We next examined the action of peroxide of lead and sulphuric acid upon benzol. By the action of these agents upon benzoic acid Meissner and Shepard* obtained

* *Ann. d. Chim.*, cxlviii., 50.
† *Zeit. f. Chem.*, 1866, 752.

succinic acid and carbonic anhydride. Benzol and PbO_2 were shaken together in a flask and sulphuric acid (sp. gr. 1·56) run in from a drop-funnel. Vigorous acion accompanied by frothing takes place in the cold at first, afterwards gentle heating is required to complete the action. After twelve hours heating the undecomposed benzol was removed by distillation, the liquid diluted with water, and filtered. The black residue consisted mostly of PbO_2 and $PbSO_4$, and contained no organic acid. The clear liquid was treated with $BaCO_3$ in excess, filtered, and the filtrate evaporated to dryness. It furnished a barium salt soluble in water, containing 36·50 per cent of barium and corresponding in every respect with benzoate of barium. The free acid from this salt showed all the physical properties of benzoic acid. The yield is much larger than by the action of MnO_2 and H_2SO_4 upon benzol. Carbonic anhydride is formed also in large quantities in the oxidation with PbO_2 and H_2SO_4.

The statements regarding the action of potassium permanganate upon benzol differ. Berthelot* obtained oxalic acid by the action of alkaline permanganate solution upon benzol, while Adrienz† found formic acid to be the product of the oxidation in an acid solution. The action is certainly very slow. A neutral solution of permanganate failed to attack benzol perceptibly in two weeks, as was proved by the weight of benzol recovered. A strongly acid solution in twelve days oxidised one-fourth of the benzol present, but we could not detect the production of solid or liquid products, while boiling with alkaline permanganate solution for six hours failed to oxidise any of the benzol.

We examined the action of PbO_2 and dilute nitric acid upon benzol. We boiled 50 grms. of benzol, 104 grms. of nitric acid (sp. gr. 1·4), 222 grms. of water, and 30 grms. of lead peroxide with a return cooler for sixty hours. After removal of the undecomposed benzol the dilute acid deposited a crop of crystals which proved to consist of oxalic acid, and no other oxidation-product was observed. Leeds‡ obtained oxalic acid by the oxidation of benzol with ozone and with hydrogen peroxide.

By oxidising benzol with a solution of chromic acid in acetic acid, and also by the action of potassium bichromate and sulphuric acid, we obtained only carbonic anhydride.

II. *Action of Isobutyric Acid upon Aniline.*

Under my direction Mr. F. L. Bardwell has examined the action of isobutyric acid upon aniline in the presence of zinc chloride. Kahlbaum's isobutyric acid was mixed with pure aniline in the proportion of one molecule of the acid to one molecule of aniline. The liquids were shaken together, but no evidence of chemical action could be detected; a small quantity of anhydrous zinc chloride was then added, whereupon the mixture at once turned to a mass of crystals, and a decided rise in the temperature of the mixture was observed. The crystals were easily soluble in water, and were decomposed by dilute caustic alkalies in the cold and aniline set free. The crystals were doubtless aniline isobutyrate. The crystalline mass obtained by the action described above was placed in a flask, melted, and boiled for from one to two hours beneath a return cooler. At the end of this time the flask was cooled, and contained then a solid mass of crystals. These crystals were washed with dilute hydrochloric acid to remove any undecomposed aniline. They proved to be somewhat soluble in cold water and easily soluble in hot water. Caustic alkalies did not attack them in the cold, but, upon heating, decomposed them, furnishing aniline. The substance was crystallised repeatedly from water and analysed when the melting-point was constant, with the following results:—

0·1535 grm. of substance furnished 0·1130 grm. of H_2O and 0·4165 grm. of CO_2.

0·9110 grm. furnished 68·14 c.c. of N at 20° and 760 m.m.

	Found.	Theory for Isobutyranilide.
H	8·54 per cent.	7·97 per cent.
C	73·99	73·61
N	8·56	8·58

These results show conclusively that the substance is isobutyranilide, isomeric with the butyranilide obtained by Gerhardt,* by the action of a mixture of butyric acid and butyryl chloride upon aniline. Isobutyranilide crystallises from water in colourless prisms which melt at 102·5° without decomposition. It distils also without decomposition. It is somewhat soluble in cold water, easily soluble in hot water, alcohol, and ether. The yield of the anilide is increased by heating the mixture of aniline, isobutyric acid, and zinc chloride in closed tubes at 150°. If aniline and anhydrous isobutyric acid are heated without zinc chloride in a similar manner the anilide can be obtained, but only with difficulty and in small quantities.

Nitric acid acts with great violence upon isobutyranilide, and all attempts to isolate a nitro-compound in a pure condition failed. By the action of bromine upon the anilide a monosubstitution-product was obtained. The anilide was dissolved in cold water, and a current of air charged with bromine water passed through the solution. A heavy precipitate of a yellowish colour separated. This substance was very insoluble in water but readily soluble in hot dilute alcohol. It was purified by repeated treatment with animal charcoal in an alcohol solution, and repeated crystallisations from this solvent, and was finally obtained in colourless needle-shaped crystals.

A bromine estimation furnished the following figures:—

0·1569 grm. furnished 0·1220 grm. of AgBr.

	Found.	Theory for $C_6H_4BrNHC_4H_7O$.
Br	33·15	33·05

The brom-isobutyranilide melts at 128°, but can be sublimed undecomposed at a somewhat lower temperature. It is soluble in hot water and slightly in cold water, but could not be obtained from water in a crystalline form. It is easily soluble in alcohol. It is unaffected by cold caustic alkali, but hot caustic alkali dissolves it slowly without decomposition. By heating in a closed tube at 125° for several hours with aqueous hydrochloric acid it was decomposed, and furnished the hydrochloride of para-brom-aniline. The free base obtained from this hydrochloric acid salt melted at 67°.† The compound obtained by the action of bromine upon isobutyranilide is, therefore, para-brom-isobutyranilide. The formation of an isomer was not observed. The para-brom-isobutyranilide was treated with a mixture of nitric acid and sulphuric acid, in the manner recommended by Nölting and Collin‡ for the production of nitracetanilide, and furnished a nitro-compound difficult to purify, but which, after repeated crystallisations from alcohol, yielded a yellow crystalline product, melting at 111·5°, containing 36·37 per cent of bromine, and agreeing in all respects with para-brom-orthonitraniline.§

III. *The Ethyl-orthotoluidines.*

In the course of an investigation upon the products of oxidation of the substituted aromatic amines, Mr. R. L. Chase has prepared under my direction the ethyl-ortho-toluidines. These compounds were prepared by Reinhardt and Staedel,‖ but they furnished no description of their characteristics.

Ethyl-ortho-toluidine.

Ethyl iodide combines with great readines with ortho-toluidine. If mixed in the proportion of 1 mol. of ethyl iodide to 1 mol. of ortho-toluidine, and allowed to stand

* *Compt. Rend.*, lxiv., 35.
† *Berichte der Deut. Chem. Gesell.*, vi., 443.
‡ *Berichte der Deut. Chem. Gesell.*, xiv., 975.

* *Ann. d. Chem.*, lxxxvii., 166.
† Körner, *Jahres. f. Chem.*, 1875, 356.
‡ *Berichte der Deut. Chem. Gesell.*, xvii., 262.
§ Hübner, Retschy, *Berichte d. Deut. Chem. Gesell.*, vi, 796, and Körner, *Jahres. f. Chem.*, 1875, 328.
‖ *Berichte d. Deut. Chem. Gesell.*, xvi., 29.

for twelve hours at the ordinary temperature, the mixture becomes a solid crystalline mass consisting of the hydriodide of ethyl-ortho-toluidine. We dissolved this salt in water, in which it is very soluble, and added caustic potash solution, by which a base was set free as an oil. This oil dried over $CaCl_2$, and fractionated, furnished a product which boiled at 204° to 206°, and gave the following figures upon analysis:—

	Found.	Theory for Ethyl-ortho-toluidine.
C	79·52	80·00
H	10·03	9·63
N	10·34	10·37

Ethyl-ortho-toluidine is a thin yellowish oil which gradually turns pink upon standing. Our product boiled at 204° to 206°, and remained liquid at −15°. Its specific gravity is 0·5934 at 15·5° compared with water at the same temperature. Its platinum salt separates as an oil, and cannot be obtained in a state of purity owing to the ease with which it is decomposed. It resembles closely the corresponding salt of ethyl paratoluidine.* The hydrochloric acid salt of the base could not be isolated. The hydriodic acid salt separates from water as a jelly, but can be crystallised from alcohol, in which it is less soluble. An iodine estimation in the hydriodide thus purified gave 48·39 per cent of iodine, while the theory requires 48·29 per cent. The acet-compound can be obtained either by the action of acetyl chloride or acetic anhydride upon the base. It is somewhat soluble in water, easily soluble in alcohol and benzol, and separates from these solvents as an oil. It boils between 254° and 264°, and solidifies after long standing.

A nitrogen estimation in the acet-compound gave—

	Found.	Theory for Acetethyl-ortho-toluidine.
N.. ..	8·34 per cent.	7·91 per cent.

The ethyl-ortho-toluidine furnishes, by the method employed by Fischer† for preparing nitroso-methyl-aniline, a nitroso-compound. This compound was purified by distillation with steam, and is a dark brown oil which cannot be distilled alone without decomposition.

A nitrogen estimation gave—

	Found.	Theory for Nitroso-ethyl-ortho-toluidine.
N	16·63	17·05

Diethyl-ortho-toluidine.

When ethyl-ortho-toluidine is heated with an excess of ethyl iodide at 100° for six hours in a closed tube the mixture turns to a mass of white crystals soluble in water. An aqueous solution of this salt treated with caustic potash solution yielded a free base, which was dried over $CaCl_2$, fractionated, and proved upon analysis to be diethyl-ortho-toluidine.

	Found.	Theory for Diethyl-ortho-toluidine.
C	80·54	80·98
H	11·06	10·43
N	9·25–9·23	8·58

Diethyl-ortho-toluidine appears to have been first prepared by Baeyer and Caro,‡ but is not described by them. Our product boiled between 203° to 208°, and was a limpid oil, closely resembling the mono-compound. Its hydriodide is less soluble in water than that of ethyl-ortho-toluidine, and crystallises from it in beautiful prisms, which contain 1 mol. of water of crystallisation, and melt at 72° to 73°. An iodine estimation in the anhydrous salt gave 43·78 per cent of iodine, while the theory requires 43·64 per cent. The yield of diethyl-ortho-toluidine was 70 per cent of the theoretical quantity.—*American Chem. Journ.*, vol. vii., No. 2.

* Morley and Abel, *Ann. d. Chem.*, xciii., 311.
† *Ann. d. Chem.*, cxc., 151.
‡ *Berichte d. Deut. Chem. Gesell.*, x., 1262.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 17th, 1886.

Dr. Hugo Müller, F.R.S., President, in the Chair.

(Concluded from vol. liii., p. 306.)

65. "*The Estimation of Free Oxygen in Water.*" By Miss K. I. Williams and Prof. W. Ramsay.

The authors have instituted a comparison of Schützenberger's methods of estimating free oxygen in water with each other and with the gasometric method with favourable results. Schützenberger's first method, which consists in adding sodium hyposulphite to a measured quantity of water, using indigo-carmine as an indicator, is stated by him to estimate only half the amount of free oxygen; his second method, in which water containing free oxygen is added to indigo-white, turning it blue, and the amount of oxidised indigo-white is estimated by hyposulphite, was regarded by him as the only accurate one. The authors disprove the assertion, and show that there is a preliminary stage in the first process when colour disappears; but that on standing for some time a blue colour appears, to destroy which permanently requires such an addition of hyposulphite as to make the total amount equal to that employed in operating according to the second method. The proportion of hyposulphite used during the first stage of Method 1 to the total amount used is 3 to 5; but they believe that this proportion was conditioned by the temperature and dilution prevailing during the experiments. It is also shown that hyposulphite of soda reacts to some extent with hydrogen dioxide, thus negativing the statements of Schützenberger's of König.

66. "*Note as to the Existence of an Allotropic Modification of Nitrogen.* By Miss K. I. Williams and Prof. W. Ramsay.

Attention was some time ago directed to the existence of an allotropic modification of nitrogen by Mr. J. Stillingfleet Johnson, who stated that an active modification of this element could be prepared by heating a mixture of potassium nitrite and ammonium chloride solutions; and that on passing the evolved gas over heated platinum sponge along with hydrogen, ammonia was formed. The support lately given to this statement by the experiments of Profs. J. J. Thomson and Threlfall has suggested the propriety of testing Johnson's statements by further experiments; the results, however, have been negative. The hydrogen used in the experiments was prepared by the action of chlorhydric acid on granulated zinc. It was collected in a gasholder, and dried by passing it first through sulphuric acid and then over phosphoric anhydride. In preparing the nitrogen 85 grms. of potassium nitrite were dissolved in distilled water, and added to a solution of 53·4 grms. of ammonium chloride; some ammonia and then some crystals of cupric chloride were introduced. On the addition of a sufficient proportion of this latter compound a steady stream of gas came off and was collected in a gasholder. In order to dry it and remove any oxides of nitrogen or ammonia present in the gas, it was first passed through a tube containing pumice-stone soaked in an acid solution of ferrous sulphate, next through a wash-bottle parly filled with sulphuric acid, over pumice-stone soaked with Nessler's reagent, then over pumice-stone soaked with sulphuric acid, and then through a tube filled with phosphoric anhydride. At this point the two streams of gas were brought together by a T-tube, and the mixture passed over heated platinum sponge into bulbs containing chlorhydric acid. At the end of each experiment the contents of the bulbs was washed into an evaporating basin and evaporated over a water-bath; the residue was then dissolved in distilled water, and tested for ammonia with Nessler's reagent.

The first experiment was made with about 4·38 litres of nitrogen prepared at a temperature of about 100°, the result being that the Nessler's reagent was coloured merely a faint yellow. In a second experiment the nitrogen used was evolved at first from the mixed solution by external application of heat, but on adding more cupric chloride the reaction went on alone, and the temperature was lower than in the first experiment. To get accurate results the capacity of the nitrogen gasholder was gauged; when full of water it contained 8·481 litres, equal to 7·7031 litres at 0° C. and 760 m.m. After using the whole of this nitrogen, at the end of the experiment the same tint was obtained as that given by 1·10 c.c. of ammonium chloride solution in 100 c.c. of distilled water with Nessler's reagent, 1 c.c. of the ammonium chloride containing 0·00019107 grm. NH_4Cl, or 0·00005 grm. N. Therefore the amount of "active nitrogen" was only 0·000055 grm. in the 7·7031 litres.

To obtain better results, if possible, during the preparation of the next gasholder full of nitrogen, the flask from which it was evolved was carefully kept below 50° C., the temperature being watched by means of a thermometer placed in the cork of the flask. In this case the ammonia formed produced the same tint with Nessler's reagent as that given by 1·14 c.c. of the standard ammonium chloride solution, proving the presence of only 0·000057 grm. "active nitrogen" in 7·7031 litres. It is evident, therefore, that these experiments fail to corroborate Mr. Johnson's results.

67. "*The Presence of a Reducing Agent, probably Hydrogen Peroxide, in Natural Water.* By Professor RAMSAY.

Distilled water, as well as ordinary tap water, has a reducing action on potassium permanganate. The amount of the reducing agent is increased by evaporation, even when all possibility of contamination with solid organic impurity is excluded. The amount of reduction is far too great to be ascribed to the nitrites present in the water. The experiments described in the paper show under what circumstances and to what extent this substance—which is probably hydrogen dioxide—is produced. If this supposition be correct, and the active substance in natural water be really hydrogen peroxide, it becomes of importance to ascertain its action on organic impurities contained in many natural waters. Experiments were therefore made quantitatively on the action of dilute solutions of peroxide of hydrogen on urea, and it was found that the urea is slowly oxidised on standing: the rate of this action has also been measured. (Comp. H. B. Dixon, *Chem. Soc. Trans.*, 1886, p. 108.)

68. "*Evaporation and Dissociation.* Part IV. *A Study of the Thermal Properties of Acetic Acid.*" By W. RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

This paper contains a record of measurements of the relative density of liquid acetic acid at 13·11° (water at 4° = 1·0), the number obtained being 1·05682; its expansion up to a temperature of 280°, at which the volume of 1 grm. is 1·5172 c.c.; its vapour-pressures, which reach 24,600 m.m. at 280°; and the density of its saturated and unsaturated vapour at different temperatures and pressures. The minimum value of the density of the saturated vapour is at 150°, and is equal to 50·06 (H = 1·0); it increases both with rise and with fall of temperature. The values of $\frac{dp}{dt}$ have also been calculated, and from them and from the other data the heats of vapourisation have been deduced. Here, again, there is a maximum value at 110·6; the latent heat at this point is 92·8° C., and decreases both with rise and fall of temperature. Diagrams are appended contrasting the behaviour of acetic acid with that of alcohol and of ether.

69. "*Note on the Vapour-Densities of Chloral Ethyl-Alcoholate.*" By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

This paper contains an account of determinations of the densities of the saturated and unsaturated vapour of chloral ethyl-alcoholate. The amount of dissociation is always very great, the percentage number of molecules decomposed being never less than 75. Owing to the very small variation of vapour-density under different conditions of pressure and temperature, to the impossibility of obtaining very concordant results with such a substance, and to the fact—noticed to a smaller extent with acetic acid—that on decreasing the volume condensation begins before the pressure has reached its maximum, it is impossible to draw any very definite conclusion regarding the relation of the density of the saturated vapour of this body to the temperature, but it may be stated that a rise in the density of the saturated vapour with fall of temperature could not be detected. The density of the unsaturated vapour diminishes with rise of temperature at constant pressure, and with fall of pressure at constant temperature.

70. "*The Nature of Liquids as shown by a Study of the Thermal Properties of Stable and of Dissociable Bodies.*" By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

After Deville advanced the theory of dissociation, its opponents endeavoured to explain the abnormality of the vapour-density of unstable bodies by ascribing it to a deviation from Avogadro's law supposed to occur in many liquids at temperatures and pressures near their condensation points. No complete research having been made to compare the behaviour of stable and of dissociable bodies in this respect, the authors have investigated the thermal properties of alcohol, ether, acetic acid, and chloral alcoholate. In all cases they have found abnormality at high pressures. But whereas with alcohol and with ether the density of the saturated vapour becomes and remains normal below certain temperatures, with acetic acid the density when at its lowest is abnormally high and increases with fall as well as with rise of temperature. The two theories alluded to above, by which attempts have been made to explain this abnormal density, are (1) that the gaseous molecules exercising attraction on one another are thereby drawn closer together, and (2) that gaseous molecules combine to form more complex molecules such as are by many supposed to exist in liquids. It appears to the authors inconceivable that this effect should be produced by the same cause under conditions so totally different: for at low temperatures the stability of a saturated vapour is greater while the molecules are necessarily further apart; and at high temperatures, owing to the high pressure, the molecules are in closer proximity, while the stability is necessarily decreased. With acetic acid it appears therefore that the abnormality at high temperatures is due to a physical cause, common to all liquids, but at low temperatures must be ascribed to some sort of chemical combination between the gaseous molecules.

71. "*The Electromotive Forces Developed during the Combination of Cadmium and Iodine in Presence of Water.*" By A. P. LAURIE, B.A., B.Sc.

The author has determined by means of a Thomson electrometer the electromotive forces of cells consisting of a cadmium and a platinum plate immersed in a solution of cadmium iodide containing free iodine. In one set of experiments, the amount of cadmium iodide in solution was constant and the amount of iodine was varied; in another the amount of cadmium iodide varied, the solution being in each case saturated with iodine; in a third, a constant amount of iodine but varying amounts of cadmium iodide were used. The result of the experiments is to show that if cadmium and water containing cadmium iodide and free iodine are brought together, a considerable electromotive force is developed, which steadily falls. This depends on the facts (1) that as the free iodine is diminished, the electromotive force falls gradually at first, but more rapidly the less iodine there is present; (2) that as the cadmium iodide solution increases in strength, the electromotive force falls off very rapidly while very small quantities of the salt are present, but more and more slowly as the amount

of salt present becomes considerable. In both cases the change may be represented by a continuous curve. The actual values are given in the paper.

72. "*Detection and Estimation of Iodine, Bromine, and Chlorine.*" By M. DECHAN.

To separate iodine from a mixture of chloride, bromide, and iodide, the author distils with a concentrated solution of potassium bichromate (40 grms. $K_2Cr_2O_7$ to 100 c.c. water); on repeating the distillation, after adding a small quantity of sulphuric acid, the bromine only passes over provided that the solution be not too concentrated. The apparatus is therefore so arranged that by means of a stopcock funnel water may be added whenever necessary. The following results are quoted:—

Iodine.		Bromine.		Chlorine.	
Taken.	Found.	Taken.	Found.	Taken.	Found.
0·01443	0·01441	0·0126	0·01254	0·0123	0·0122
0·0288	0·02833	0·0252	0·0250	0·056	—
0·0576	0·05628	0·0504	0·05009	0·194	—

73. "*The Analysis of Alloys and Minerals containing the Heavy Metals, Selenium, Tellurium, &c.*" By THOMAS BAYLEY.

The metals precipitable as sulphides are commonly divided into the two groups of those forming sulphides insoluble in alkaline sulphides, and those whose sulphides are soluble; the method of extraction with an alkaline sulphide is often applied in qualitative but less often in quantitative analysis, owing to the difficulty of completely removing the soluble sulphides when once they have been precipitated in admixture with the other sulphides. Instead of precipitating both classes together, it is better, the author finds, to prevent the precipitation of the thiosalt forming elements altogether, experience having shown that the process conducted on this principle is at once accurate and very easy of execution. The process recommended consists in passing sulphuretted hydrogen into a boiling solution containing the substance together with citric and tartaric acids and caustic soda.

NOTICES OF BOOKS.

Oils and Varnishes. Edited by JAMES CAMERON, F.I.C. London: J. and A. Churchill.

THIS work forms one of "Churchill's Technological Handbooks," and deals with an important subject concerning which correct practical information is not easily to be met with.

From the preface, Cooley's "Cyclopædia" appears to have served as the basis of the present volume, to which has been added information derived from more recent sources.

The author discusses, in his first chapter, the chemistry of oils, considering the animal and vegetable fixed oils, followed by the volatile oils, fatty and essential. Under animal oils we find mention of "insect oils," which are certainly, so far, more curious than industrially or commercially important. Then follow in succession the empyreumatic oils, the waxes, and the mineral oils. Under the last head we find instructions for the storage of petroleum, and notes on the construction and management of petroleum lamps.

The eighth chapter discusses the purification, bleaching, and refining of oils. Here we note that one of the best processes—probably *the* best as far as medicinal oils are concerned—has been accidentally overlooked. Concerning this process we may mention the interesting fact that it was lately purchased by a certain firm for several hundred pounds, as a secret, although it was at the time in print and open to all the world.

The chapter on testing oils is the most extensive in the book, and relates to their purity, lubricating properties, and illuminating efficiency. Here we find a Miss Kate Crane credited with the discovery "that the cohesion figures of oils may be usefully employed as tests of the identity and purity of oils." The authority quoted is the *American Journal of Pharmacy*, iv., p. 406. Unfortunately the date of this communication is not given. This is an important point as regards priority, since in the CHEMICAL NEWS for 1868 (vol. xviii., p. 299) is to be seen a paper, by Dr. R. Carter Moffat, entitled "Oleography: being a Process for the Utilisation of Tomlinson's Cohesion Figures." Miss Crane, as quoted in the work before us, makes no reference either to Dr. Moffat or Mr. Tomlinson, nor does Dr. Moffat refer to her researches. Thus, pending the date of vol. iv. of the *American Journal of Pharmacy* being ascertained, we are unable to decide who is the "first and true inventor."

The spectroscopic examination of oils, proposed by Doumer, is briefly described, but the author expresses no opinion as to its trustworthiness. At the conclusion of this chapter the author discusses photometry and the "standards of light," which he justifiably regards as by no means perfect. Concerning the cost of different sources of light, he shows that taking petroleum at 1s. per gallon, and coal-gas at 3s. 6d. per 1000 cubic feet, "a given quantity of light from the former costs only about half what it does when obtained from the latter, with the additional advantage that properly purified petroleum oil in burning does not produce sulphur compounds."

The concluding chapters are devoted to resins and varnishes.

The entire work is replete with valuable information, and will prove a great convenience to persons connected with the trades and manufactures interested.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cii., No. 24, June 15, 1886.

Absorption-Spectra of Oxygen.—J. Jansen.—This paper will be inserted in full.

Remarks on the Decomposition of Ammoniacal Salts by Metallic Bases and Oxides.—M. Berthelot.—Berthelot explains the preparation of ammoniacal gas by its volatility opposed to the fixity of the alkaline bases. This explanation is exact but insufficient, since it does not explain the partial character of the reaction of most metallic oxides. Neither does it render intelligible what takes place in presence of water, in conditions where the ammonia remains dissolved; nor why lime, baryta, and strontia dissolve in solutions of ammonium chloride, whilst ammonia does not precipitate calcium, barium, and strontium chloride. Even in the case of soda in presence of an excess of water, the theory of Berthelot would involve the distribution of the acid between the soda and the ammonia in a proportion determined by their capacity of saturation and their quantity. But the author has proved by thermic determinations that soda displaces ammonia in dilute solutions entirely or approximately, independent of volatility and whatever may be the relative proportions. Lime acts in the same manner, contrary to the ancient principle of insolubility. It is, therefore, not surprising that in default of water ammoniacal gas escapes; its displacement not being really due to its volatility, but to a previous and independent chemical reaction.

Ammonia in Soils.—Th. Schlœsing.—The author raises the question: Are the quantities of ammonia con-

tained in vegetable soils comprised, generally, between 0 and 20 m.g., comformably to the determinations of M. Boussingault, of the author, and of other analysts, or are they from 78 to 118 m.g., as found by MM. Berthelot and André? The relations between the soil and the atmosphere, concerning the exchange of ammonia, depend upon the solution arrived at.

Lavoisier and the Commission of Weights and Measures.—E. Grimaux.—Lavoisier, at the time of his arrest, was a member of the Commission of Weights and Measures. From an unpublished document which has fallen into the hands of M. Grimaux it appears that on Dec. 19, 1793, the Commission addressed to the Committee of Public Safety a formal request for his liberation as necessary for the verification of the numerous standards of weights and measures with which the Commission was then engaged, researches on the weights and the expansion of metals being in particular interrupted by his absence. This document is signed by Borda as president and Haüz as secretary, and is entirely in the handwriting of the latter. The reply was curt and significant: "The Committee of Public Safety, considering that the citizen Lavoisier is entered upon the list of the ex-Fermiers-generaux, arrested in execution of the decree of the National Convention (Nov. 24, 1793), passes to the order of the day." In proof that this attempt on the part of the Commission to save their illustrious colleague was not free from danger, it appears that a few days later the Committee of Public Safety decreed that not only Lavoisier, but Borda, Laplace, Coulomb, Brisson, and Delambre should cease from that date (Dec. 26) to be members of the Commission of Weights and Measures."

Spectroscopic Observations on Fabry's Comet.—L. Cruls.—The three bands characteristic of the compounds of carbon were distinctly seen.

Law of the Electro-conductivity of Saline Solutions of Mean Concentration.—E. Bouty.—As the conclusion of a mathematical investigation the author states that the excess of the specific resistance of a salt beyond its limit value is almost inversely as the mean distance of its molecules.

Relation between the Coefficient of Self-induction and the Magnetic Action of an Electro-magnet.—M. Ledebour.—The curves obtained are shown in diagrams.

On Phosphorus Pentasulphide.—F. Isambert.—This compound is obtained by exposing to the rays of the sun a mixture of sulphur and phosphorus dissolved in carbon disulphide. A yellowish white powder is deposited, which in about a year crystallises as a confused mass. It ignited it burns in the air, giving off sulphurous and phosphoric acids. If heated it melts, and at high temperatures it distils with great difficulty.

Principle of Equivalence in the Phenomena of Chemical Equilibria.—H. Le Chatelier.—The experimental law which serves as the basis of rational mechanics: "Two forces equal to a third are equal among themselves and reciprocally," is exact also in the case of chemical equilibria. But in view of such an application it is preferable to modify the statement by suppressing the notion of force, the source of continual equivocations when we are speaking of phenomena which cannot be produced by direct muscular effort. It will then take the following form:—"In every phenomenon of equilibrium two material systems, which are equivalent as regards a third, *i.e.*, which can singly form an equibrium to it, will remain equivalent as regards any other system to which they are opposed, and if opposable to each other they form a mutual equilibrium. The author applies this principle to evaporation, to dissociation, to solubility, the decomposition of salts by water, the double decomposition of salts, and the action of presence.

Sodium Mono-orthophosphate and Mono-arseniate.—A. Joly and H. Dufet.—This paper relates principally to the crystalline forms of the two salts.

A Compound of Methylic Alcohol and Anhydrous Baryta.—M. de Forcrand.—The author has obtained a compound of the formula $2C_2H_4O_2,3BaO$.

On Butyl Monochloracetate.—G. Gehring.—This compound is a colourless, very mobile liquid, of a pleasant fruity odour and a burning taste. It dissolves in alcohol in all proportions; in water it is very sparingly soluble. It is slowly saponified by potash lye. Its specific gravity at 0° is 1·103.

Compounds of Water and Alums.—E. J. Maumené.—The alums are considered as combined with one and the same quantity of water, 24 mols. But a careful analysis shows that in potash-alum the water amounts to 28·73, almost 5 mols. in excess of the classical formula.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 5, May, 1886.

Report Delivered by A. E. Bérard on behalf of the Committee of Chemical Arts on Amagat's 'Differential Ebullioscope."—This instrument cannot be intelligibly described without the accompanying cut.

Treatment of Certain Mineral Phosphates of the Type known under the Name of "Redonda."—W. J. Williams.—Taken from the *Journal of the Society of Chemical Industry.*

MISCELLANEOUS.

Result of the Nitrate of Soda Prize.—Carrying out the scheme of prizes offered by the Committee of the Saltpetre Producers' Association (Comité Salitero at Iquique, Chili), for the best popular Essay treating of the "Importance of Nitrate of Soda as a Manure, and the Best Mode of its Application," the Judges—Prof. L. Grandeau, Nancy (France); Prof. Adolf. Mayer, Wageningen (Holland); Prof. A. Petermann, Gembloux (Belgium); Prof. G. Thoms, Riga (Russia); Prof. Paul Wagner, Darmstadt (Germany); Mr. R. Warington, Rothamsted (England)—have examined the Essays sent in, namely, 13 German, 13 English, 4 French, and have made the following awards:—1. To the Essay with the motto "Grau, theurer Freund, ist alle Theorie" a partial prize of £350 (7000 marks). 2. To the Essay with the motto "Pour pratiquer l'agriculture. . . . ." a partial prize of £150 (3000 marks). On opening the accompanying envelopes the author of the First Essay was found to be Dr. A. Stutzer, Principal of the Agricultural Experimental Station at Bonn; and the author of the Second Essay, M. A. Damseaux, Professor in the Agricultural Academy at Gembloux. It should be remembered that Essays competing for the second part of the prize offered—namely, £500 for the best Essay treating of the same subject, on the basis of *new, personal, experimental investigations*—must be sent to one of the above-named Judges on or before January 1st, 1887.—On behalf of the Comité Salitero, P. Wagner.

MEETINGS FOR THE WEEK.

Monday, 5th.—Royal Institution, 5. General Monthly Meeting.
Friday, 9th.—Quekett, 8.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.
FRANKLIN BARROW,
CLAYTON
Near MANCHESTER.

THE CHEMICAL NEWS.

Vol. LIV. No. 1389.

ON SOME NEW ELEMENTS IN GADOLINITE AND SAMARSKITE,* DETECTED SPECTROSCOPICALLY.

By WILLIAM CROOKES, F.R.S., V.P.C.S.

The recent discovery by my distinguished friend M. de Boisbaudran† of the existence of a new element which he calls Dysprosium makes it unadvisable on my part, as a fellow investigator in spectroscopic research, to delay any longer the announcement of some of the results I have obtained during the fractionations of the samarskite and gadolinite earths.

I will first take the earths which give absorption spectra when their solutions are examined by transmitted light. These occur chiefly at the higher end, beginning with didymium and proceeding, through samarium, holmium, &c., to erbium, which is one of the least basic. The earths which give phosphorescent spectra chiefly occur at the lower end, but each group overlaps the other; for instance yttria occurs above erbia.

One of the highest of the absorption-spectrum earths is didymia. The spectrum of didymium, as generally met with, is well known, and is given in my paper on "Radiant Matter Spectroscopy: Part 2, Samarium." (par. 135).

It has long been suspected that didymium is not a simple body, and in June, 1885, Dr. Auer v. Welsbach announced that by a series of many hundred fractional crystallisations he had succeeded in splitting up didymium into two new elements, one giving leek-green salts and the other rose-red salts. The green body he called Praseodymium and the rose-red Neodymium. I have not found that my method of fractionation gives a decomposition similar to this; probably didymium will be found to split up in more than one direction, according to the method adopted; but by pushing the fractionations at the didymium end of the series to a considerable extent, a change gradually comes over the spectrum. At the lower end the earth gives an absorption spectrum such as is usually attributed to didymium, but with no trace of some of the bands in the blue end, the one at λ 443 being especially noticeable by its absence. The intermediate earths give the old didymium spectrum, the relative intensities of some of the bands varying according to the position of the earth in the series, the band 443 becoming visible as the higher end is approached. The highest fractions of all give the band 443 one of the most prominent in the spectrum, being accompanied by other fainter bands which are absent in the lowest didymium spectrum.

In my note-book, under date 3rd March, 1886, after discussing the absorption spectrum given by one of my earths rather low down in the series (fraction −3), and comparing coincidences of the lines with those given by holmia, erbia, didymia, thulia, and samaria, I remark "the big blue line (λ 451·5) is still unclaimed." In ignorance that my friend M. de Boisbaudran was on the same track, and running me somewhat close, I deferred further examination of these fractions till a few months longer work had been performed on them, when I hoped to get fuller evidences of a new absorption spectrum. This big line in the blue, λ 451·5, now proves to be the characteristic line of dysprosium. This line does not occur in didymium. The next strongest line, λ 475, is coincident with a very faint line in the old didymium spectrum, and it also falls within a broad band of samarium. M. de Boisbaudran says that this line is not due either to didymium, erbium, or samarium; as it follows the same variations of intensity as the other lines of dysprosium he considers it due to the same element.

The earth (−3), which I have already mentioned as giving the broad black band (451·5) of dysprosium, shows this band wider (and therefore presumably stronger) than in the spectrum given by M. de Boisbaudran, without the slightest trace of the band 475, which, according to M. de Boisbaudran, should be wider and almost as dense as the band 451·5. It is obvious therefore that the element giving the band 475 cannot be the same as the one causing the band 451·5, and if the body giving the strongest of these is called dysprosium another name must be chosen for the element which gives rise to the absorption-band 475.

And now comes the question: What is the origin of band 475? In remarks made on the band 443 I mentioned that it is accompanied by other fainter lines. One of these occurs at 475, and therefore I was prepared to connect these bands as being due to one and the same element; but M. de Boisbaudran, in his description of the spectrum of dysprosium, has shown that band 475 can be obtained strong in the absence of 443. The bands 443 and 475 therefore are not caused either by didymium, dysprosium, or any hitherto identified element; consequently each must be regarded as characteristic of a new body.

I now come to a branch of the subject which promises to yield results even more fruitful than those given by the examination of absorption spectra: I refer to the spectra yielded by some of the earths when phosphoresced *in vacuo*. This method has been so fully explained before the Royal Society, in my papers on "Radiant Matter Spectroscopy," that I need not repeat it.

In my Bakerian Lecture on Yttrium* I described the phosphorescent spectrum of this earth, and gave a drawing of it. In the Samarium paper† I gave a similar description and drawing of the samarium spectrum, and also described and illustrated some anomalous results obtained when yttria and samaria were mixed together. Under the conditions described in the paper a sharp and brilliant orange line made its appearance, which at that time seemed as if it belonged to the samarium spectrum, and was only developed in greater intensity by the presence of yttria. This explanation, however, did not satisfy me, and I called the line (λ 609 = $\frac{1}{\lambda^2}$ 2693) "the anomalous line," intending to return to it at the first opportunity.‡ I have since further investigated the occurrence of this line, with more than usual good fortune in the extent and importance of the new facts thereby disclosed.

Systematic fractionation was carried on with the portions of the general series giving the strongest appearance of line 609, and it soon became apparent that the line closely followed samarium. The presence of yttria was not necessary to bring it out, although by deadening the brightness of the other bands it was useful, not seeming to affect the line 609. Several circumstances, however, tended to show that although line 609 accompanied samarium with the utmost pertinacity, it was not so integral a part of its spectrum as the other red, green, and orange lines. For instance, the chemical as well as physical behaviour of these line-forming bodies was different. On closely comparing the spectra of specimens of samaria from different sources, line 609 varied much in intensity, in some cases being strong and in others almost absent; the addition of yttria was found to greatly deaden the red, orange, and green lines of samarium while yttria had little or no effect on

* A Paper read before the Royal Society, June 10th, 1886.

† *Comptes Rendus*, cii., p. 1003, May 3, 1886.

* *Phil. Trans*, Part 3, 1883.

† *Ibid.*, Part 2, 1885.

‡ In paragraph 146, page 713, of the Samarium paper already quoted, speaking of this line, I said it was "so unlike the bands usually met with in the spectra of phosphorescent earths as to suggest the explanation that some other spectrum-forming body was present in the mixture."

the line 609; again, a little lime entirely suppressed line 609, while it brought out the samarium lines with increased vigour. Finally, attempts to separate line 609 from samarium and those portions of the samarskite earths in which it chiefly concentrated resulted in sufficient success to show me that, given time enough and an almost inexhaustible supply of material, a separation would not be difficult.

But what was then practically impossible to me, restricted with limited time and means, Nature has succeeded in effecting in the most perfect manner. I had been working on samarskite, and many observations had led me to think that the proportion of band-forming constituents varied slightly in the same earth from different minerals. Amongst others, gadolinite showed indications of such a differentiation, and therefore I continued the work on this mineral. Very few fractionations were necessary to show that the body giving line 609 was not present in the gadolinite earths; no admixtures of yttria and samaria from this source giving a trace of it. It follows therefore that the body whose phosphorescent spectrum gives line 609 occurs in samarskite, but not in gadolinite; thus it cannot be due to samarium, yttrium, or a mixture of these two elements; the only other probable alternative is that the source of this line is a new element.

Chemical fractionation is very similar to the formation of a spectrum with a very wide slit and a succession of shallow prisms. The centre portion remains unchanged for a long time, and the only approach to purity at first will be at the two ends, while a considerable series of operations is needed to produce an appreciable change in the centre.

During the later fractionations of the gadolinite earths another set of facts, formerly only suspected, have assumed consistent form. The spectrum bands which hitherto I had thought belonged to yttria soon began to vary in intensity among themselves, and continued fractionating increased the differences first observed. It would exceed the limits of a preliminary note were I to enter into details respecting the chemical and physical reasons which lead me to the definite conclusions I now bring before this Society. More than 2000 fractionations have been performed to settle this single point. I will content myself with stating the results. The earth hitherto called yttria appears to be a highly complex body, capable of being dissociated into several simpler substances, each of which gives a phosphorescent spectrum of great simplicity, consisting for the most part of only one line.

Taking the constituents in order of approximate basicity (the chemical analogue of refrangibility) the lowest earthy constituent gives a violet band (γ 456), which I have reason to believe belongs to ytterbia. Next comes a deep blue band (λ 482); then the strong citron band (λ 574), which has increased in sharpness till it deserves to be called a line; then come a close pair of greenish blue lines (λ 549 and λ 541, mean 545); then a red band (λ 619), then a deep red band (λ 647), next a yellow band (λ 597), then another green line (λ 564); this (in samarskite yttria) is followed by the orange line (λ 609) of which I have already spoken; and finally, the three samarium bands remain at the highest part of the series. These for the present I do not touch, having my hands fully occupied with the more easily resolvable earths.

In the *Comptes Rendus* for April 19th, 1886, M. de Boisbaudran announces to the Academy that M. de Marignac, the discoverer of Yα, had selected for it the name Gadolinium. In February last I gave a short note on the earth Yα,* in which I described its phosphorescent spectrum (agreeing exactly with that given by Yα of M. de Marignac's preparation). Referring to my paper it will be seen that Yα is composed of the following band-forming bodies:—(541, 549), (564), (597), (609), (619), together with a little samarium. Calling the samarium an impurity, it is thus seen that gadolinium is composed of at least four simpler bodies. The pair of green lines (λ 541 and λ 549, mean 545), being the strongest feature in its spectrum, may be taken as characteristic of gadolinium: the other lines are due to other bodies.

It is by a method of his own, differing from mine, that M. de Boisbaudran has obtained phosphorescent spectra of some of these earths. He takes the induction spark between the surface of a strong and acid solution of the metallic chloride, and a clean platinum wire a few millims. above it. The platinum wire is kept negative and the solution positive; it is then observed that in many cases a thin layer of fluorescent light is seen at the surface of the liquid. This layer gives a spectrum of nebulous bands. For the sake of brevity I will adopt M. de Boisbaudran's term, and call this process the *method of reversion* (the direction of the spark being reversed). As this method is entirely different to the one I adopt, it is not surprising that the results also are different. Experimenting in this way M. de Boisbaudran has obtained, among others, two bands (λ 573 and λ 543·2), which he considers to be caused by two elements, named respectively Zα and Zβ, and which he considers new, at all events if we except terbium and possibly the elements of what was formerly called holmium. His method fails to show any spectrum in solutions of yttria which by my method give the yttria bands with the greatest brilliancy; while conversely his method shows a fluorescent spectrum in solutions of earths separated as widely as possible from yttria, chemically as well as spectroscopically. My experiments on both these methods tend to the conclusion that our bands are not due to the same cause, although M. de Boisbaudran's experiments have led him to the opposite conclusion. The band of Zβ (543) falls between the double green band of gadolinium (549 and 541), and the band of Zα (573) would come very near the citron line (574).

A hitherto unrecognised band in the spectrum by absorption or phosphorescence is not of itself definite proof of a new element, but if it is supported by chemical facts such as I have brought forward there is sufficient *prima facie* evidence that a new element is present. Until, however, the new earths are separated in sufficient purity to enable their atomic weights to be approximately determined, and their chemical and physical properties observed, I think it is more prudent to regard them as elements on probation. I should therefore prefer to designate them provisionally by the mean wave-length of the dominant band. In this I am following the plan adopted by astronomers in naming the minor planets, which are known by a number encircled by a line. If, however, for the sake of easier discussion among chemists a definite name is thought more convenient I will follow the plan frequently adopted in such cases, and provisionally name these bodies as shown in the Table. (See next page).

The initial letters D, S, and G recall the origin of the earths respectively from Didymium, Samarskite, and Gadolinite.

The radiant-matter test for these phosphorescing bodies proves itself every day more and more valuable, as one of the most far-searching and trustworthy tools ever placed in the hands of the experimental chemist. It is an exquisitely delicate test capable of being applied to bodies which have been approximately separated, but not yet completely isolated, by chemical means; its delicacy is unsurpassed even in the region of spectrum analysis; its economy is great, inasmuch as the test involves no destruction of the specimen; its convenience is such that any given test is always available for future reference, and the quantity of material is limited solely by the power of the human eye to see the body under examination. Beyond all these in importance is its trustworthiness. I should be exceeding the legitimate inference from experience were I to say that the test is infallible; but this I may say—during the five years in which this test has been in daily use in my laboratory, I have never once been led to view its indications with suspicion. Anoma-

* *Proceedings of the Royal Society*, No. 243, February, 1886.

Position of lines in the spectrum.	Scale of spectroscope.	Mean wave-length of line or band.	$\frac{1}{\lambda^2}$	Provisional name.	Probability.
Absorption bands in violet and blue..	8·270	443	5096	Dα	New.
	8·828	475	4432	Sβ	New.
Bright lines in—					
Violet	8·515	456	4809	Sγ	Ytterbium.
Deep blue	8·931	482	4304	Gα	New.
Greenish blue (mean of a close pair)	9·650	545	3367	Gβ	Gadolinium, or Zβ.
Green	9·812	564	3144	Gγ	New.
Citron	9·890	574	3035	Gδ	New, or Zα.
Yellow	10·050	597	2806	Gε	New.
Orange	10.129	609	2693	Sδ	New.
Red..	10·185	619	2611	Gζ	New.
Deep red	10·338	647	2389	Gη	New.

lies and apparent contradictions have cropped up in plenty, but a little more experiment has always shown that the anomalies were but finger-posts pointing to fresh paths of discovery, and the contradictions were due to my own erroneous interpretation of the facts before me.

ON THE FLUORESCENCE FORMERLY ATTRIBUTED TO YTTRIA.

By M. LECOQ DE BOISBAUDRAN.

THE Academy doubtless remembers the discussion which has taken place before it, between Mr. Crookes and myself, on the subject of the origin of the fluorescent bands which my learned English friend attributes to yttria, while I have considered them due to impurities from which it has only been very difficult to purify true yttria.

I have shown * that purified yttria (characterised by the electric spectrum obtained with its hydrochloric solution) no longer gives rise to fluorescent phenomena, not only when its hydrochloric solution is treated by the method of *reversement*, but also when its anhydrous sulphate is submitted to the action of the electric discharge *in vacuo*, by the beautiful process discovered by Mr. Crookes.

By recently recognising the complexity of old yttria,† and by announcing the existence of new elements characterised by the fluorescent bands formerly attributed to yttria, it appears to me, therefore, that Mr. Crookes has in reality completely come round to the opinion I have always maintained; although he has not referred to this opinion (doubtless through inadvertence) in the article which he caused to appear in the English journal *Nature* on the 17th of June last.‡

According to the latest work of Mr. Crookes, the fluorescent bands of the old yttria, although they are not due to yttria properly so called, have really origins different from those of my fluorescences, Zα and Zβ, obtained by *reversement*;—fluorescence Zα and Zβ, which, I think, have the same chemical origin as Mr. Crookes's fluorescences *in vacuo*.

In the hope of contributing to clear up this question, I have made the following experiments:—

After a long series of careful fractionations I have obtained a terbia § which gives, by *reversement*, a magnificent fluorescent spectrum, composed of all the bands Zβ‖ with only a faint trace of the yellow band of Zα.

I introduced a little of this terbia into purified yttria, which no longer gave *in vacuo* Mr. Crookes's old fluorescence, or, at least, only showed an insignificant trace of the citron band. The anhydrous sulphate of this mixture (yttria soiled by a little terbia) showed *in vacuo* a fine fluorescence, in which glowed the two green bands of the drawing given by Mr. Crookes as that of old yttria; the relative intensities of these bands, their width, &c., exactly conform to this drawing. In short, these are Mr. Crookes's two green bands obtained with a trace of terbia which only gave by reversement one single wide band. In this experiment the spectrum of samarium was well developed,* but the whole of the spectum of Zβ was very faint, except the two green bands of which I have just spoken. The colour of the fluorescence, to the naked eye, was of a very clear orange-yellow colour.

Having repeated the experiment with lime instead of yttria, I obtained *in vacuo* a magnificent fluorescence of a beautiful green colour, and more brilliant than that realised by yttria, mixed with terbia. This time the green band was not doubled. The other bands of Zβ were good. The fluorescence of Zα (feeble with terbia by reversement) was well developed, and comprised the yellow and blue bands. On the contrary, the two green rays of Mr. Crookes could not be seen, and the samarium bands were weak.

I then made a similar double experiment, starting with an earth giving by *reversement* a fine spectrum of Zα and a more feeble one of Zβ; this earth contains a notable quantity of erbia and holmia.

With purified yttria, mixed with a small quantity of the earth in question, the fluorescence *in vacuo* gave a very fine citron band, apparently identical with that described by Mr. Crookes, that is to say, a nebulous band on which appears a very narrow ray, with sharp edges, which is not seen in this form in the spectrum obtained by reversement. The green band is fainter than the citron band, but it is double, as in Mr. Crookes's drawing. The colour of the fluorescence, to the naked eye, is much whiter than with yttria and the brightness is superior.

Two principal explanations appear to me possible for these observations:—

1. The citron and double green bands of Mr. Crookes are no other than my reversement bands of Zα and Zβ, modified in their structure by the nature of the solid body which serves, as it were, as a diluent for the active matter.

2. The citron and double green bands have origins different from those of my Zα and Zβ bands, and we therefore must admit the singular fact that Mr. Crookes's bands are produced, to the exclusion of bands Zα and Zβ, in the presence of excess of yttria, while the reverse takes place in the presence of lime.

Mr. Crookes, in *Nature*, appears to attribute to gadolinium the double green band; this led me to try the above experiments.

* *Comptes Rendus*, p. 591, Sept. 14, 1885; and CHEMICAL NEWS, vol. liii., p. 299.

† *Nature* (English), June 17, 1886, p. 160-62.

‡ The article in *Nature*, to which M. de Boisbaudran refers, was only an abstract of my Royal Society paper. On referring to the complete paper, which immediately precedes this article, it will be seen that, whilst I have by no means come round to M. de Boisbaudran's opinion, I have not failed in my duty to give the fullest credit to M. de Boisbaudran for his beautiful discoveries.—W. CROOKES.

§ The fluorescence of Zβ, by *reversement*, is at its maximum intensity in the terbias most coloured reddish brown; Zβ therefore appears to be identical with Tr, or, at least there is as yet no proof against this identity.

‖ *Comptes Rendus*, p. 899, April 19, 1886.

* My terbia, the concentrated hydrochloric solution of which no longer gave, in a thickness of about 15 m.m., an appreciable trace of the absorption bands of samarium, evidently still contains a very small quantity of this body, as well as of gadolinium, the electric spectrum of which has also ceased to be discernible.

With yttria the bands of Sm and Gd are produced almost alone. With lime the bands of $Z\alpha$ and $Z\beta$ appear to the complete exclusion of the two green bands of gadolinium, and the almost complete exclusion of those of samarium.*

It will be seen that there is still much of interest to be done on this subject.—*Comptes Rendus*, vol. cii., pp. 1536—9. June 28, 1886.

DECOMPOSITION OF AMMONIA BY ELECTROLYSIS.

A Lecture Experiment.

By the Rev. A. IRVING.

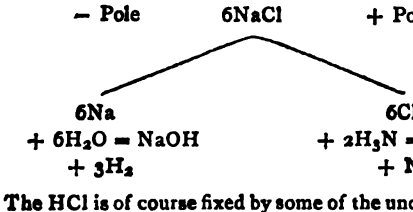
At the present moment, when electrolytic processes are receiving so much attention, it is worth while, perhaps, to draw attention to the following experimental demonstration of the proportion in which hydrogen and nitrogen gases separate out from ammonia. So far as I am aware, it has not as yet found its way into any English text-book of chemistry; but its extreme simplicity and its manageability render it peculiarly suitable for lecture demonstrations, while it has also a special interest as illustrating those *secondary actions* which take place in electrolysis in many cases. The experiment is not original, and I am indebted for it to Prof. Wislicenus of Würtzburg, of whose excellent "Lehrbuch"† I have made very free use for some years past.

An ordinary three-tubed voltameter of Hoffman's form, such as is commonly used for the electrolysis of water, is so modified in its construction as to have two carbon pencils of the material used in the ordinary Bunsen-cell introduced to serve as electrodes, one at the bottom of each of the two tubes, which are furnished at the top with stop-cocks; the carbon pencils being inserted through corks, which plug the tubes, and are made to carry platinum wires for connection with the conducting wires of the battery.

The actual electrolyte is a concentrated solution of sodium chloride, and with this is mixed about one-tenth of its volume of the strongest solution of ammonia. By the substitution of carbon for platinum the action of the nascent chlorine upon that metal, which would vitiate the results, is obviated.

In a few minutes, with a fairly strong battery (4 to 6 Bunsen or Grove cells), a considerable volume of each of the gases N_2 and H_2 is liberated in the separate tubes, the volume of the latter being three times that of the former, and these are tested in the usual manner.

The following scheme may be taken as accurately representing what goes on:—



The HCl is of course fixed by some of the undecomposed ammonia ($6NH_3+6HCl = 6NH_4Cl$), and, remaining in solution as NH_4Cl, does not interfere with the volumetric results.

It will be seen that nothing is assumed here but—

(1.) The axiom that things which are equivalent to the same thing are equivalent to one another.

(2.) The known reaction of sodium on water,—

$$Na_2+2H_2O=2NaOH+H_2.$$

(3.) The equally well known reaction of chlorine upon ammonia, $3Cl_2+2NH_3=6HCl+N_2$.

(4.) The law of Avogadro.

Upon these the following train of reasoning is based without much difficulty:—

Starting with the decomposition of the NaCl, and confining our attention at first to what takes place at the negative pole, where Na is removed from the salt and where the free H_2 appears, we know that for every three molecules (or six atoms) of H_2 set free $6H_2O$ has undergone decomposition; from the known composition of NaCl and known electrolytic laws we know that the removal of 6 atoms of Na at the cathode must be accompanied by the release of 6 atoms of chlorine at the anode; and from the known composition of HCl (the only known compound of these two elements) we know also that these 6 atoms of chlorine must take up 6 atoms of H, the equivalent of the 6 atoms ($3H_2$) liberated at the cathode; and from these 6 atoms of H in the ammonia, two atoms (1 molecule) of N_2 are set free, as seen in the experiment.

It need scarcely be added that, for the demonstration of the proportion which a given volume of NH_3 bears to the sum of the volumes of the N_2 and H_2 produced by its decomposition, under the same physical conditions, the decomposition of the dry gas by the spark stream in a eudiometer over mercury is as necessary as ever.

Wellington College, Berks.
July 2, 1886.

ON THE DETECTION OF CALCIUM IN THE PRESENCE OF STRONTIUM.

By C. L. BLOXAM.

If a solution of calcium sulphate be mixed with ammonia and a little solution of arsenic acid, it yields, on stirring with a glass rod, a highly crystalline precipitate, which is deposited very strongly on the lines where the glass rod has rubbed the tube. Under an inch objective, this precipitate is seen to consist of fine needles and flat rectangular prisms, and agrees with the description given by Wach of the salt $CaNH_4AsO_4.7Aq$. This precipitate is nearly as insoluble as calcium oxalate. A solution containing Ca in 113,235 of water, which gave a distinct crystalline precipitate almost immediately with ammonia and ammonium oxalate, also gave one, after a minute or two, with ammonia and arsenic acid, and this precipitate was far more crystalline than the oxalate.

When strontium chloride is precipitated by excess of sulphuric acid, the minute quantity of strontium left in the solution is not precipitated by ammonia in excess and arsenic acid, though it gives a slight precipitate with ammonia and ammonium oxalate.

A solution containing one part (0·0381 grain) of calcium and fifty parts of strontium, acidulated with HCl, precipitated by H_2SO_4, filtered, mixed with excess of ammonia, cooled, and stirred with a little solution of arsenic acid, gave a copious crystalline precipitate. With one part (0·019 grain) of calcium and 100 parts of strontium the precipitate appeared after two or three minutes.

With the same weight of calcium and 500 parts of strontium, the filtrate from the $SrSO_4$ was evaporated to a small bulk, mixed with excess of ammonia, filtered from a further deposit of $SrSO_4$, and stirred with arsenic acid; in a few seconds the precipitate of ammonium-calcium arsenate was deposited on the lines of friction, and identified by the microscope.

Samples of strontium nitrate and carbonate, purchased as pure, were found to contain much calcium when examined in this way.

* Mr. Crookes has, however, shown that lime brings out the bands of samarium; but may it not be that the production of other fluorescences opposes the ordinary action of lime?

† "Lehrbuch der Anorganischen Chemie," § 147.

The ammonium-magnesium arsenate appears, under an inch glass, in tufts of minute needles, and could not be mistaken for the calcium salt.

King's College, July 5, 1886.

EYSTER'S SCHEME FOR QUALITATIVE ANALYSIS.

By ROBERT B. WARDER.

IN the *American Chemical Journal* (vol. vii., pp. 21-26) appears a method for the qualitative determination of the bases without direct use of hydrogen sulphide, which will prove very convenient in many cases. Having used this method in part with my own classes during the past year, a few notes may be of service to those who have not yet tried it.

The use of sulphuric acid to precipitate Ba, Sr, Ca, and Pb (as copied from Zettnow's scheme) appears to be a needless complication, and may be simply omitted, other provision being made for the detection of these metals.

The principle underlying Eyster's most important modification will be seen at a glance from the following table, from which also an outline of the scheme may be deduced.

Basis of Usual Scheme.			Basis of Eyster's Scheme.	
Sulphides precipitated by H_2S in presence of HCl.	Sol. in Am_2S	As, Sb, Sn		Sulphides sol. in Am_2S.
	Insol. in Am_2S	Hg, Pb, Bi, Cd, Cu	Insol. in cold dilute HCl	Sulphides (or hydrates) precipitated by AmOH and Am_2S.
Not precipitated by H_2S in presence of HCl.		Ni, Co, Zn, Mn, Fe, Al, Cr	Sol. in cold dilute HCl	

Cobalt and nickel hold an exceptional position, their sulphides being practically insoluble in cold dilute chlorhydric acid, and yet not precipitated in presence of that reagent by hydrogen sulphide. Under the new scheme they are dissolved by nitric acid, and held in solution by excess of ammonia with the cadmium and copper. Eyster precipitates the four sulphides (after testing for Cu with ferrocyanide), dissolves the cadmium with sulphuric acid, and tests for nickel with the bead in presence of copper. My own experiments shows that cadmium may also be separated from nickel and cobalt by adding ammonium sulphide in presence of potassium cyanide, and the following provisional scheme is offered:—

Add KCy and Am_2S, yellow precipitate, *cadmium*.
Add $C_2H_4O_2$ to filtrate, black precipitate, *copper*.
Add HCl to filtrate, black precipitate, *nickel*.
Look for Co in solution.

This use of acetic and chlorhydric acids was proposed by Mr. J. Swearingen, and has been partially tested in this laboratory by himself and by Mr. E. G. Eberhardt. Acetic acid precipitates copper at once; a part of the cobalt also separates on standing one or two days.

In a mixture of cobalt and nickel sulphides, the former (as is well known) can usually be detected at once with the borax bead. The latter may be partly dissolved in yellow ammonium sulphide and re-precipitated by chlorhydric acid. I have rarely failed to obtain a sufficient quantity of nickel by this means to give distinct colour to the bead.

Details will be found in Eyster's careful paper, which has induced me to present these notes at once, instead of waiting to make a more thorough examination of the special features proposed.—*American Chemical Journal.*

THE ATOMIC WEIGHT OF SILVER AND PROUT'S HYPOTHESIS.*

By LOTHAR MEYER and K. SEUBERT.

THE calculation of the atomic weights of many of the elements depends, as is well known, upon that of silver, so that the sharpest possible determination of this is desirable in order to obtain accurate results, without which a discussion of Prout's hypothesis, *as far as this is concerned with facts*, is unprofitable.

For this reason J. S. Stas, in his masterly investigations, used the utmost care in fixing the stoichiometrical relations between silver and oxygen, and confirmed these by indirect methods with wonderful accuracy. The hypothesis of Prout, that all atomic weights are rational multiples of that of hydrogen, is not borne out by Stas's work; even when the relation of oxygen to hydrogen = 15·96 : 1 is rejected as doubtful, and 16 : 1 is taken in its stead, silver and a number of other elements—among them those whose ratio to hydrogen is most accurately known, differ in their atomic weights far more from whole numbers than experimental errors can account for. The accuracy and reliability of Stas's results seemed so far beyond all doubt that one of the most celebrated advocates of Prout's hypothesis could explain the contradiction of the theory by the experiments only by questioning the stability of the foundation of the atomic theory, *the constancy of chemical proportions*, and consequently the possibility of preparing chemically pure substances.†

In 1878 Dumas,‡ also a supporter of Prout's teaching, published the results of a few experiments, in which he succeeded in separating oxygen from pure silver which had been fused with a mixture of borax and saltpetre. A kilogrm. of the silver was heated to redness in a flask connected with a Sprengel's pump, and the evolved oxygen collected and measured.

For each kilogrm. of silver there were obtained, in four different experiments, 82, 226, 140, and 249 m.grms. of oxygen.

As Stas subjected the silver used in his investigations to the same treatment, this too, as Dumas claimed, must have contained oxygen. In spite of all the care and skill of the experimenter, his results with metallic silver were affected by a constant error which increased the atomic weight of the silver and lowered those of the halogens; the relation of silver to chlorine, instead of being 108 : 35·47, as was then generally believed, became 108 : 35·5, in accordance with Prout's hypothesis.‖

It cannot be denied that this objection is worthy of attention, and we are justified consequently in briefly considering its effect on the result by briefly discussing a few experiments.

If Stas really worked with silver containing oxygen his error will consist in this, that instead of using 1000 parts of silver he used only 999·751 parts.§ In transforming

* See *Berichte der Deutschen Chemischen Gesellschaft*, xviii., 1098 Translated by W. S. Bayley.

† Marignac, *Archives des Sciences Physiques et Naturelles* (nouv. per.), ix., 1860, p. 105 and ff. "Il ne m'est pas absolument démontré, que bien des corps composés ne renferment pas constamment et normalement un excès, très faible sans doute, mais sensible dans des expériences très-délicates, de l'un de leurs éléments." See also *Ann. Chem. Suppl.* IV., p. 202.

‡ *Com tes Rend*, lxxxvi., 65—71. *Ann Chim. Phys.* [5], xiv., 289.

§ A conclusion of Dumas's which can be contested on more grounds than one. See below.

‖ In the most unfavourable case, when the silver contains the largest amount of oxygen observed by Dumas, viz., 0·249 part per 1000.

silver into silver chloride, Stas obtained by four different methods*:—

From 969·3548 grms. Ag 1287·7420 grms. AgCl,
in which Ag : AgCl = 1 : 1·32845.

This relation is changed by Dumas's correction into—

969·1134 grms. Ag = 1287·7420 grms. AgCl,
or Ag : AgCl = 1 : 1·32872.

In the same way the correction may be applied to the cases in which silver was changed into silver bromide or iodide by synthesis. In all these cases the error might possibly have reached the maximum as observed by Dumas.

Fortunately, however, a number of experiments were made from which the amount of oxygen contained in the silver can be determined. These consist of *complete syntheses of silver bromide and silver iodide*, when the amounts of both constituents used as well as the resulting compound were weighed.

In both cases the weight of the product was found to be somewhat too low, a result which can be referred to the oxygen in the silver.†

The complete synthesis of the silver bromide yielded these figures‡:—

Ag : Br : AgBr = 210·5711 : 156·0098 : 366·5639 grms. [4]
Ag + Br = 366·5809
AgBr = 366·5639
Difference 0·0170

Calculated for the amount of silver used, this difference corresponds to 0·08073 part of oxygen in 1000 parts of silver, provided the total loss were due to escape of oxygen. The corrected weight of the silver then becomes 210·5541 grms.

Then Ag : AgBr = 210·5541 : 366·5639
= 1 : 1·74095
Instead of 1 : 1·74081.

Similarly, in the complete synthesis of silver iodide, the weight of the product is less than the sum of the weights of iodine and silver.

Stas found§—

Ag : I : AgI = 324·2571 : 381·1262 : 705·3718 grms. [5]
Ag + I = 705·3833
AgI = 705·3718
Difference 0·0115

This difference corresponds to 0·03547 parts of oxygen in 1000 of silver, so that the weight of pure silver used was 324·2456 grms. Consequently—

Ag : AgI = 324·2456 : 705·3718
= 1 : 2·17542
Instead of = 1 : 2·17535.

The comparison of these values with those obtained from the analyses of the chlorates, bromates, and iodates gives the relation of silver to oxygen.

Stas found—

$AgClO_3 : AgCl = 398·3177 : 298·4250$ grms.‖ [2]
$AgBrO_3 : AgBr = 188·5332 : 150·1671$ grms.¶ [2]
$AgIO_3 : AgI = 331·6101 : 275·3235$ grms.** [3]
Or, AgCl : O = 8·9614 : 1
AgBr : O = 11·7420 : 1
AgI : O = 14·6742 : 1.

Evidently these figures cannot be influenced by Dumas' correction, as there was no metallic silver weighed. From these figures the relation of the silver to the oxygen can easily be calculated by means of the formula*—

$$\frac{Ag}{AgR} \cdot \frac{AgR}{O} = \frac{Ag}{O},$$

in which R is one of the halogens Cl, Br, or I. According to this,—

$$Ag : O = \frac{8·9614}{1·32872} = 6·7439 : 1$$

$$Ag : O = \frac{11·742}{1·74095} = 6·7446 : 1$$

$$Ag : O = \frac{14·6742}{2·17542} = 6·7455 : 1.$$

Of these three numbers, neither of which agrees with the 6·7500 demanded by Prout's hypothesis, the third is entitled to most consideration; for, in the first an arbitrary correction is made, in the second a part of the error credited to oxygen must surely be due to some other impurity, the third is calculated from experiments made with the purest materials. This number, 6·7455, obtained from the complete synthesis of silver iodide and the analysis of the iodate, is also the mean of several other determinations made by Stas which vary between 6·7451 and 6·7458; besides, it is almost identical with 6·7456 yielded by silver iodide and iodate without the application of Dumas's correction, as well as the 6·7456 obtained by reducing silver sulphide and sulphate.

The conclusion is consequently justified, since several of Stas's determinations agree satisfactorily with one another and with the number which is certainly free from the error pointed out by Dumas, that the influence of this is confined within the limits of error, and consequently may be neglected.

If it appears strange that the silver used by Stas for determining the atomic weight exhibited only in small degree an impurity, whose amount was determined by the experiments of Dumas as being quite considerable, it must be remembered that only the oxygen present in a condensed form would influence the weight; the gaseous oxygen under the normal pressure producing an effect scarcely more noticeable than the air in which the silver was weighed. Besides, Stas always heated his silver to dark redness immediately before weighing, so that the greater part of the "occluded" oxygen either escaped or was changed into the gaseous form.

These considerations, based on the results of experiments, show, as we again emphasize, *that the determinations of the atomic weight of silver by Stas are not appreciably influenced by the oxygen which the silver retains within itself.*†

The atomic weight of silver then is, if H = 1 and O = 15·96,—

Ag = 107·66
if O = 16, Ag = 107·93;

while the figures calculated from the results of the experiments with metallic silver and silver chloride are, after applying the correction of Dumas,—

Ag = 107·63, if O = 15·96, and
Ag = 107·90, if O = 16 00

Thus we see that the atomic weight of silver is removed still farther from the whole number required by Prout's hypothesis, by the application of Dumas's correction; chlorine also still remains inconsistent with it, while a few other elements, like potassium, sodium, &c., approach or depart from it according as we take O = 16 or 15·96. Dumas has assumed, in order to explain such exceptions to Prout's hypothesis as chlorine particularly offers, that

* Lothar Meyer and Karl Seubert, *Die Atomgewichte der Elemente*. Leipzig, 1883, pp. 55 and 56, No. 41 g.

† As the difference in the case of the synthesis of silver bromide was smaller the more carefully the bromine was dried, this must in part be due to moisture in the bromine. Besides there was a small loss occasioned by washing.

‡ *Die Atomgewichte der Elemente*, &c., p. 57, No 42 b, β.

§ *Ibid.*, p. 59, No. 43 b, γ.

‖ *Ibid.*, p. 47, No. 35 b.

¶ *Ibid*, p. 47, No. 36

** *Ibid.*, p. 41, No. 37 b.

* *Die Atomgewichte der Elemente*, &c., pp. 50—52.

† W Ostwald reached the same conclusion through the theory of probabilities. See his "Lehrbuch der allgemeinen Chemie," 1884, i, 35.

hydrogen itself is composed of ultimate atoms (uratomen), of which he at first thinks there are two in one atom of hydrogen, but when this is also found not to be in accordance with the experimental results, increases the number to four.

But even this "elastic modification," as Clarke calls it, of the old theory can only be preserved, in the face of Stas's work, by decreasing the size of the unit, that is the weight of the ultimate atom, in proportion as the accuracy of our experimental work increases.

More recently,* the universal ether, with an atomic weight of 0·0001 (H = 1), has been assumed as the primitive substance of which all other elements were formed. The atomic weights of all other elements must of course be whole multiples of this, since none of them have been accurately determined to the fourth decimal place, while many are certain only to the first or second place, and some only to units of hydrogen.

Nor need it excite wonder if, as has been proposed by another writer,† every atomic weight y can be approximately calculated by the expression :—

$$y = p\ 15 - 15\ (0{\cdot}9375)^x \text{ or,}$$
$$y = 15\left(p - \left(\frac{15}{16}\right)^x\right),$$

in which p may vary between 1 and 16, but x varies from 1·50, or even ∞ ; for the fraction $\frac{15}{16}$ so nearly approaches unity that any number can be accurately expressed by the formula.

Speculations of this kind are far removed from any possibility of experimental proof, and can therefore never be expected to receive from it any support. Nor can we ever hope to receive any essential extension of our knowledge in respect to primitive matter (urmaterie) through a more accurate establishment of the atomic weights; the next important progress will rather be brought about by the decomposition of the elements into a similar substance, differing from them, however, which may be the primitive matter itself, or a condensation product of it. The solution of this question, that is, the decomposition of all the elements into one and the same original substance, we can hardly ever expect to accomplish.

From the atomic weight of silver, determined, as above shown, with the greatest accuracy, and from those of the other important elements‡ calculated by its means, it follows as a consequence that *the atomic weight of silver, as well as the atomic weights of numerous other elements, all contradict Prout's hypothesis in its characteristic original conception; it must, therefore, be looked upon as having been disproved by experiment.* In its new forms it has likewise been disproven, so far as this is possible in the present state of our knowledge. Beyond this it amounts merely to philosophical speculation concerning an idea whose probable correctness will be denied by no one,§—the unity of matter.

THE ABSORPTION-SPECTRA OF OXYGEN.

By J. JANSEN.

THE spectral study of oxygen has led the author to detect in this gas several orders of absorption phenomena. At the first is the elective action, which is manifested by the system of fine rays, first recognised by M. Egoroff. According to this author they are especially the groups A, B, and a. But besides—and here the phenomena become deeply interesting—there exists another system, consisting not of lines easily individualised, but of bands which appear very difficult to resolve. This system appears much later than the foregoing, but it is rapidly developed with the increase of density, and soon acquires the upper hand.

The two systems differ so widely in the conditions of their production that the first may be obtained without the second, and *vice versa*. But the point of chief importance for molecular mechanics, and, as will soon be seen, for celestial physics, is the law according to which these absorption phenomena are developed when the density and the thickness of the medium traversed by the luminous pencil are made to vary simultanously. It then appears that the bands are developed much more rapidly than according to the product of these two factors. To represent the phenomena the thickness traversed must be multiplied not by the density of the medium, but by its square.

Thus these bands have been obtained in a tube 0·42 metre in length, filled with oxygen at the pressure of 70 atmospheres only, whilst calculation would show nearly 860 atmospheres if—setting out from the experiment with a tube of 60 metres—we wished to fulfil the law of the product of the length by the density, *i. e.*, the condition of causing the pencil to traverse the same quantity of matter by weight.

The bands in question are the same as those mentioned in a former communication. The author then asked why these bands, obtained with thicknesses of oxygen much less than those which the light of the sun is obliged to traverse before reaching us, are not very distinctly shown in the solar spectrum? We have now the explanation of this fact, which follows from the law of the variation of these actions according to the density of the medium in which they are produced, as it will be shown. Such are the general outlines of the phenomenon in question. We shall next have to enter into the details of its exact description and applications, as well as the investigation of analogous phenomena in other gases.

In his next communication the author will describe the series of experiments which have served to demonstrate that the phenomenon in question belongs to oxygen gas. —*Comptes Rendus*, vol. cii., p. 1352.

NOTES FROM THE LABORATORY OF THE CHEMICAL EXAMINER TO GOVERNMENT, BURMA.

By R. ROMANIS.

Agricultural Experiments.

TEN plots were manured with ground bones, dissolved bones, and nitre for three years. The result shows that ground bones are the most economical manure for rice in the soil of the Irrawadi delta. The largest crop was given by a mixture of 10 cwts. ground bones with 1½ cwts. nitre per acre, viz., 2890 lbs. of grain against 1940 lbs. by the unmanured.

Composition of Grain Grown with Various Manures.

	I. 2 years unmanured.	II. 1st year, Ground Bones. 2nd year, No manure.	III. Bones, 2 years.
Cellulose	10·78	10·10	8·94
Alkaline extract.. ..	13·20	12·30	10·43
Alcoholic extract ..	2·24	1·20	1·93
Water extract	2·35	2·87	2·23
Benzol extract	4·93	2·18	3·31
Starch..	66·72	70·60	73·13

* M. Zängerle, "Uber die Natur der Elemente, &c." "Program des Kgl. Realgym. München," 1882.

† Edm. J. Mills, "On the Numerics of the Elements," *Phil. Mag.*, Nov. 1884, p. 393.

‡ *Cf.* Atomic weight tables of Meyer and Seubert. "Breitkoft u. Härtel," Leipzig, 1884.

§ *Cf.* Lothar Meyer, "Moderne Theorien," V. Auf., p. 134.

Ash of Rice. (By J. Tsaw Os White.)

	Unhusked.	Husked.
Potash	7·35	16·99
Soda	0·53	2·03
Lime	0·66	1·19
Magnesia	3·03	11·76
Ferric oxide	2·46	2·38
Phosphoric acid	10·65	45·96
Silicic „	75·32	19·69

Ash of Indigo Stem.

Potash	42·22
Soda	5·97
Lime	18·54
Magnesia	6·27
Ferric oxide	1·06
Phosphoric acid	12·55
Sulphuric „	8·45
Silicic „	4·92

Ash of Juice of Sugar-Cane Grown at Two Different Localities.

	I.	II.
Potash	33·80	36 09
Soda	19·40	2·25
Magnesia	1·42	7·81
Lime	1·38	1·39
Ferric oxide	1·59	2·17
Phosphoric acid	3·92	11·32
Sulphuric „	35·33	23·24
Silicic „	3·33	9·46
Chloride of potassium ..	—	6·24
	100	100

No. I. came from a district near the sea; the sugar is said not to crystallise. No. II. is the same cane grown at Rangoon; it crystallised without difficulty.

Specimen of Jade from Mogaung, found in the Palace at Mandalay. (By J. T. Os White).

Silica	49·13
Alumina	19·26
Ferrous oxide	6·56
Lime	11·33
Magnesia	5·80
Potash	0·91
Soda	7·07
	100·06

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 26th, 1886.

Prof. W. E. Ayrton, F.R.S., Vice-President, in the Chair.

Mr. E. M. Langley was elected a member of the Society.

The following communications were read:—

"*On certain Sources of Error in connection with Experiments on Torsional Vibrations.*" By Herbert Tomlinson.

During a long series of researches on the torsional elasticity and internal friction of metals the author has come across the following sources of error in connection with torsional vibrations. In some of the earlier experiments a horizontal brass bar was suspended by a wire and oscillated, the times of oscillation being observed by the ordinary lamp, mirror, and scale. The moment of inertia was varied by sliding two brass cylinders suspended from the bar by fine wires backwards and forwards along it. It was then found that, under certain conditions, the bar executed a few vibrations of rapidly decreasing amplitude, came to rest, and then commenced to swing again, the amplitude increasing to a maximum, again decreasing, and so on. This effect was finally traced to an approach to synchronism between the time of oscillation of the bar and that of the small cylinders about their axes of suspension, the absorption of energy being due to these being set in vibration. The effect entirely disappeared upon clamping the cylinders rigidly to the bar. On another occasion, however, the old phenomenon reappeared and, after much time spent in investigating it, was found to be due to a somewhat similar cause, a near approach to synchronism between the periods of torsional and pendulous vibrations. If the axis of the wire passed accurately through the centre of the mass of the vibrator this would not occur; but this condition it is practically impossible to fulfil. Another source of error lies in the fact that in a wire recently suspended the torsional vibration period will always be found to be slightly greater than when it has been suspended for some time and frequently oscillated.

"*On a Mode of Driving Electric Tuning-Forks.*" By Prof. S. P. Thompson.

It is invariably found that the frequency of an electrically maintained fork is continually changing. This great inconvenience the author believes to be due to the fact that the impulses are given to the prongs at a disadvantageous moment, namely, when they are at the extremities of their swings. It is desirable that the impulse should be given at the middle of the swing, and to effect this it is suggested that each fork should make and break the circuit of the magnet influencing the other one, and it was shown how the electrical connections could be made to effect this in a simple manner.

"*A Further Note on the Formula of the Electro magnet and of the Dynamo.*" By Prof. S. P. Thompson.

In a paper recently communicated by the author it was shown that an expression given by Fröhlich for the intensity of magnetisation in terms of the magnetising force was nearly identical with one derivable from a simple law enunciated by Lamont. In a recent paper Fröhlich has further developed this law, and in the present paper the author has extended Fröhlich's results, and has applied them to the various forms of dynamos.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, July 5th, 1885.

William Huggins, D.C.L., F.R.S., Vice-President, in the Chair.

The following were elected Members:—Mr. George A. Crawley, The Right Hon. W. H. Smith, M.P.

The Managers reported that they had re-appointed Professor James Dewar, F.R.S., as Fullerian Professor of Chemistry.

The Presents received since the last Meeting were laid on the table and the thanks of the Members returned for the same.

Patent Office Library.—We are requested to state that the Free Public Library at the Patent Office, 25, Southampton Buildings, Chancery Lane, W.C., will, on and after July 1st, 1886, be open to the public daily from 10 a.m. to 10 p.m., instead of, as heretofore, from 10 a.m. to 4 p.m. This library, in addition to the Specifications, Indexes, and other publications of the Patent Office, contains a large collection of the leading British and Foreign Scientific Journals, Transactions of Learned Societies, and Text-books in the various departments of Science and Art.

NOTICES OF BOOKS.

rictional Electricity. By T. P. TREGLOHAN, Head Master of St. James's Science and Art Schools, Keyham, Devonport. London: Longmans and Co.

ALMOST at the very outset of his work the author makes he judicious remark that "It should be the object of veryone studying this subject (and of course the same ule applies to every department of physical science) to est every phase of it by as many experiments as possible, hat the mind may be familiarised with the simple phe-omena which have led to marvellous discoveries." This idium he enforces by quotations from Profs. Tyndall and uthrie. The former of these authorities shows the ne-essity for learning the art of experimentation, and tells s, most truly, that thought springing from this source as "a vitality not derivable from mere book knowledge." rof. Guthrie, in his annual report on the "Examination f Training Colleges" (1882) complains that "In many ases the teaching appears to have been mainly theo-etical. Many of the answers show that the examiner ? examinee], while understanding the conventional escription of a piece of apparatus, has probably never een it, and certainly never used it. This won't do."

It is surprising how anyone can fail to see how, from hese two quotations alone, must follow the condemnation f the entire English system of education as far as the hysical and natural sciences are concerned. For if the rts of observation and experiment, and of drawing cor-ect inferences from the phenomena encountered, consti-ute the true object of the student, what ensues? His roficiency in these arts, his suggestiveness, his intel-ectual resources can never be judged by an examiner, uch less appraised in "marks." Hence, where the aining marks is the goal aimed at, the student will be udged chiefly by his power of remembering other men's iscoveries, and of talking about things rather than doing hem.

In a work which makes such admissions as those we ave just quoted, it strikes us as an incongruity when we re told that "the present volume has been prepared to eet the syllabus of the Science and Art Department for he Elementary Stage, and to satisfy the requirements of he second stage of one of the Physics Courses of the Mundella Code' as laid down by the Education Department."

As an Appendix we find the questions given out in fric-ional electricity by the Science and Art Department from 867 to 1885 inclusive.

There is here one plain question which we feel com-elled to put to all upholders of the examinational system f education: How is it that Germany not only produces much greater quantity of valuable scientific research han does Britain, but that Germans are more and more upplanting natives in our laboratories, museums, &c. ither we as a race are intellectually inferior—an alter-ative which we cannot admit if we remember Newton, oung, Davy, Faraday, Graham, Darwin, Balfour, Lyell, nd many others—or we are moving in the wrong direction s regards higher education.

The subject-matter of the book before us is, as it might e expected, free from errors, and its arrangement is very tisfactory.

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nalytical Chemistry: a Series of Laboratory Exercises constituting an Elementary Course of Qualitative Chemical Analysis, Compiled for the Use of Beginners in the Laboratory. By W. DITTMAR, F.R.S., F.R.S.E., Professor of Chemistry in Anderson's College, Glasgow. New Edition. London and Edinburgh: W. and R. Chambers.

HE first edition of this little work appeared in 1879. It id been in use in the laboratory of Anderson's College for above a year previous to its publication, and, as the author assures us, has been of great service to students.

The second edition, now before us, contains in its first part little addition or alteration, save as regards the section on Bunsen's flame-tests (p. 13), which has been contributed by Dr. Gibbs, of the Edinburgh University.

The Appendix, or purely medical portion of the treatise, has been entirely re-written.

We notice with pleasure that the work contains no reference to any "syllabus" or examination, the author's evident object being to train up his students not to "pass," but to "know,"—a very different matter.

The Camera. A Monthly Magazine for those who practise Photography. Vol. i., No. 1. June 1, 1886.

THE increase in the number of scientific journals is, we fear, out of proportion to any improvement in the demand.

Our young contemporary begins with a paper on "Photography and Astronomy," which expounds one portion—and only one—of the important services which photography is now rendering to the sciences.

Mr. J. S. Hodson, in an able article entitled "Photography in its Relation to Artistic Reproduction," seems—like too many persons in the present day—unable or unwilling to recognise the boundary between Science and Art.

We note a curious paragraph, which seems to question the instantaneous character of the illumination afforded by a lightning flash. Mr. A. S. Barber, of Philadelphia, "claims to have made two negatives of lightning subjects at night-time, the only illumination being from a single lightning-flash. Both pictures exhibit foliage which has moved during exposure. The *Journal of the Franklin Institute*, which publishes this strange information, will not vouch for the accuracy of the deductions made. We are inclined to follow the same course,"—a very prudent reservation.

La Vara de Esculapio. Vol. i., Nos. 1 and 2.

THIS new hygienic journal, which appears fortnightly at Barcelona, bears the motto "Hominum sanitas suprema lex esto," and may be regarded as a movement in the right direction. It seems to wage war especially against quackery and adulteration. As a specimen of the former evil it mentions the "neurate of gold," a proprietary medicine lately introduced into Spain, and which is said by the makers to consist of "nerve-molecules, combined with gold." It is edifying to see how skilfully the charlatans of the present day catch up and utilise scientific terminology.

As regards adulteration the state of Spain must be unsatisfactory. We find that the editors, having visited a great number of wine and vinegar shops, have not met with pure wine or vinegar in any of them. We wish our contemporary success. He will evidently find a superabundance of work.

Industries. A Journal of Engineering, Electricity, and Chemistry for the Mechanical and Manufacturing Trades. Vol. i., No. 1.

THE bulk of this new technical paper is devoted to subjects which do not fall within our cognisance. Thus we find here articles on diamond-mining and diamond-cutting, on Admiralty and dockyard administration, on cask-making machinery, on coal-getting machinery, Japanese industries, the "Manchester Guardian" office, the mining prospects of South Staffordshire, &c. There is a relatively brief department of industrial chemistry conducted by Mr. Watson Smith, of the Victoria University.

Perhaps the most satisfactory feature, from our point

of view, is the article on technical education taken in conjunction with passages in other parts of the journal bearing on the same momentous question. It is here admitted that "until our educational arrangements are improved we must expect to see large numbers of Germans employed in our drawing offices and engineering establishments—we may add "in our laboratories and chemical works." But are our educational arrangements in process of improvement? Do not our movements in this sphere consist mainly in multiplying examinations? In the journal before us we read elsewhere "in Britain, at present, in the excitement about technical education, a great deal of what passes under that name does not deserve to be called *education*; it is mere cramming the facts, figures, and methods of work, which may be useful enough in the way of instruction when superadded to education, but by itself is not only useless, but very likely may become worse than useless in engendering a condition of mind in the students which unfits them for original thought."

Industries has before it a field in which there is scope for good work.

Patent Centrifugal Drying, Separating, and Filtering Machines.

MESSRS. WATSON, LAIDLAW, AND CO. have forwarded us a catalogue of improved devices and appliances which must be found of no small importance to dyers, chemical manufacturers, &c. The firm have produced small centrifugals, of 18, 12, and even 8 inches diameter, suitable for experiments on the small scale, and even for laboratory purposes. These machines may be driven by hand, but they can also be arranged to be propelled by electric power at 2000 to 4000 per minute. We should recommend this catalogue to the attention of our readers.

CORRESPONDENCE.

PURIFICATION OF AIR.

To the Editor of the Chemical News.

SIR,—In two letters in your valuable Journal—the one on June 18th from Mr. R. Warington, F.R.S., and the other on June 25th from Dr. Percy Frankland—reference is made to a paper communicated to the Royal Society by the latter gentleman on June 10th, to the effect "that air when passed slowly through a 2-foot tube, coated internally with gelatin, deposits practically the whole of the micro-organisms which it carries in suspension, within the first half of its course through the tube."

This fact is not new, but was, I believe, first noticed by Hesse, and by him (*Mittheilungen aus dem K. Gesundheitsamte*, Band iii., p. 182), was made the basis of a very convenient and elegant process for the determination of the number of micro-organisms in air.

This method I have used, in conjunction with Drs. Haldane and Anderson, in an extensive investigation of the Air of Dwellings and Schools, more particularly in reference to Disease. The results of this research we communicated to the Royal Society, through Sir Henry Roscoe, on the same day (June 10th) as Dr. Percy Frankland's paper.

The same method we also recently adopted in an examination of the air in the sewers under the Houses of Parliament, an investigation which we undertook at the request of the Select Committee on the Ventilation of the House; also in a series of experiments with which we are at present engaged on the air in the sewers of Dundee. One of the chief results of our investigation of the air of sewers is that they behave practically like Hesse's tubes, so that sewer air contains, as a rule, fewer micro-organisms than the outside air at the same time.

The further interesting fact appears also to have been noticed by Dr. P. Frankland, that, though the air in its passage through the tube has deposited all its micro-organisms, it may still contain an abundance of suspended matter. We have also observed this phenomenon in our researches, and referred to it at length in our paper to the Royal Society. We have suggested a method by which the number and relative density of the dust particles in air may be determined, at the same time as the micro-organisms. The paper was also accompanied by a photograph illustrating the phenomenon in question. I quite agree with Dr. P. Frankland that the deposition of the micro-organisms and dust in passing through a tube is due to gravity alone, for like him, and as Hesse also observed, we have always found that they are practically confined to the *bottom* of the tube.

In this connection it is also interesting to note that moulds, as a rule, settle out much less rapidly than bacteria; a fact which, I think, was first observed by Hesse.—I am, &c.,

THOS. CARNELLEY.

University College, Dundee, June 30, 1886.

"ALLOTROPIC NITROGEN."

To the Editor of the Chemical News.

SIR,—In a "Note as to the Existence of an Allotropic Modification of Nitrogen," communicated by Miss E. J. Williams and Professor Ramsay to the Chemical Society, June 17th, 1886, and reported in your last issue, the authors describe experiments which they describe as "testing my statements" as to the existence of an allotropic modification of nitrogen.

Their results, which they say "fail to corroborate" mine, are briefly as follows:—

7·7 *litres* of nitrogen gas, obtained from a mixture of potassium nitrite and ammonium chloride in aqueous solution by the application of heat, and of crystals of cupric chloride, yielded ammonia, corresponding to 0·00005 gramme of nitrogen. *Qualitatively*, these results do corroborate mine, since ammonia was obtained from the purified nitrogen, mixed with hydrogen and passed oves platinum sponge.

I presume, therefore, that the failure to corroborate alluded to by the authors had reference to the *quantity* of ammonia produced.

The only *quantitative* estimations of the yield of ammonia obtained from a given volume of nitrogen gas published by me are to be found in my book, "On Certain Indications of the Existence of an Allotropic Modification of Elementary Nitrogen, and on the Synthesis of Ammonia," (J. and A. Churchill, 1885). For reasons fully detailed in that work (pp. 18 to 20), I discarded the use of a mixture of ammonium chloride and potassium nitrite altogether in making *quantitative* estimation of the proportion of active nitrogen in the gas obtained by heating solutions of ammonium nitrite, and employed for that purpose a pure solution, prepared by passing N_2O_3 (or the yellow gas resulting from the action of HNO_3 upon As_2O_3) into a solution of ammonia (sp. gr. 0·880 (*vide* pp. 21 *et seq.*).

My results tended to show that as much as 1 per cent. of the gas was active.

Therefore, as regards the *quantity* of ammonia produced, my results are enormously discrepant from those of Miss Williams and Prof. Ramsay; but, as the conditions of our respective experiments also differed widely, I do not think that any importance can be attached to the comparison.—I am, &c.,

G. STILLINGFLEET JOHNSON.

King's College, London, July 5, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 25, June 21, 1886.

Certain Double Phosphates of Thorium and Potassium and of Zirconium and Potassium.—L. Troost and Ouvrard.—The composition, crystalline form, and the properties of thorium metaphosphate have shown that no argument can be drawn from this salt to assimilate thorium and zirconium and to ascribe to the former the formula of a dioxide rather than of a monoxide. The authors have sought by preparing a certain number of thorium phosphates and analogous compounds of zirconium if it is possible in the dry way to verify the analogy between thoria and zirconia pointed out by different observers. Potassium metaphosphate and pyrophosphate yield, with thorium and zirconium, double phosphates which have analogous compositions, but which are not isomorphous. Potassium orthophosphate yields double phosphates which have different compositions. There is no isomorphism between thoria and zirconia, as obtained by the calcination of the double phosphates at a very high temperature.

Ammonia in Soils.—MM. Berthelot and André.—A voluminous continuation of the controversy with M. Schlœsing, which the authors finish by saying that they have nothing either to add or to withdraw.

Announcement of the Discovery of a New Metal, Austrium.—Lecoq de Boisbaudran.—In the *Monatshefte für Chemie* of April, 1886, appears the announcement of the discovery of a new metal, which the author, Herr E. Linnemann, has named "austrium." According to the description of its chemical properties, the method of its extraction from the orthite of Arendal and its electric spectrum, austrium appears to the author to be very probably gallium, the presence of a small quantity of which in orthite is not surprising. The two rays of austrium, measured approximately by Herr Linnemann, are $\lambda = 403{\cdot}0$ and $416{\cdot}5$, those of gallium being $403{\cdot}2$ and $417{\cdot}05$ (the mean of the author's measurements and those of MM. Delachanal and Mermet). In austrium, as in gallium, the ray 417 is the stronger.

Vapours Emitted by a Mixture of Volatile Substances.—P. Duhem.—The author concludes that the equations of equilibrium given by thermo-dynamics render it possible to demonstrate that—"The partial pressure of the vapour emitted by each of the two liquids mixed is inferior to the saturated vapour-tension of the same liquid taken in a state of purity.

Dynamics of the Molecule of Water, Speed of Propagation of Sound; Compressibility, Fusion-Heat of Ice; Specific Heat.—M. Langlois.—A mathematical paper, not susceptible of useful abstraction.

Calorimetrical Study of Iron at Elevated Temperatures.—M. Pionchon.—About 700° iron undergoes a modification characterised by an absorption of heat which is extremely rapid within an inconsiderable range of temperature. In the discussion on reading this paper E. Becquerel remarked that iron, about 600°, presents another very remarkable change in its physical properties, since the attractive action exerted upon it by magnets is then suddenly diminished. As nickel and cobalt, from a magnetic point of view, present effects of the same order, but at different temperatures, nickel at 400° and cobalt at white redness, it would be very interesting to ascertain if the thermic capacity of these metals does not undergo changes analogous to those of iron near those temperatures.

Conditions realising the Maximum of Useful Work in an Electric Distribution.—M. Vaschy.—Not capable of useful abridgment.

Presence of a New Element in Samarskite.—W Crookes.

Dissociation of Hydrated Copper Sulphates.—H. Lescœur.—The author's conclusions are that the crystalline hydrate has great difficulty in parting with the water which it contains, and also in re-absorbing it, a phenomenon which seems in connection with the hardness of the crystals. If finely pulverised the salt is dissociated more readily, a property which seems connected with the greater surface exposed. If placed in the stove or on a hot plate the product is dehydrated in a most irregular manner, constituting a mixture far from homogeneous, a property which seems to depend on its bad conductivity for heat.

On the Alkaline-Earthy Selenides.—Ch. Fabre.—A thermo-chemical examination of the calcium, strontium, and barium selenides.

Action of Acids and Bases upon Solutions of Tartar-Emetic.—M. Guntz.—The author shows that on adding an acid to such solutions the whole of the antimony is not precipitated, and that the precipitate is not the terhydrated oxide. Bases, on the other hand, precipitate pure anhydrous antimony oxide.

Action of Water and Ammonia upon Methylene Chloride.—G. André.—The destruction of methylene chloride by an aqueous solution of ammonia takes place at a lower temperature than in contact with water alone.

New Properties of Cyanised Camphor.—A. Haller.—The author has obtained campho-carbonic ether, showing that cyanised camphor may be considered as the nitrile corresponding to campho-carbonic acid.

Contribution to the Study of the Alkaloids.—Oechsner de Coninck.—The author has treated with potassa certain pyridic ammonium iodides, obtaining colouring-matters. Pyridin iodomethylate, dissolved in a slight excess of absolute alcohol and treated with potassa takes a fine red colour; excess of alkali turns it to a brownish red and then to a dirty red. The liquid deposits a brown resin which dissolves in alcohol with a deep red colour; hydrochloric acid turns this solution to a bright red, acetic acid to an orange-red, ammonia to a ruby-red, or, in excess, to a dirty red. An excess of water slightly acidified with hydrochloric acid turns it to an orange-red. Pyridin iodoethylate and α-picoline iodomethylate and iodoethylate also give rise to coloured reactions.

On the Normal Dinitriles, $CN-(CH_2)_n-CN$.—L. Henry.—The accumulation of nitrilic nitrogen in the carbonated molecules has a powerful influence upon the properties of the entire molecule, increasing its volatility and rendering it more apt to crystallise.

Chemical Studies on the Products of the Eruption of Etna in May and June, 1886.—L. Ricciardi.—The sands collected and the lavas contain silica, chlorine, phosphoric acid, alumina, ferric and ferrous oxides, manganese, chrome, calcium, magnesium, potassium, and sodium.

Volumetric Determination of Sulphur in Sulphides Decomposable by Hydrochloric or Sulphuric Acids.—Fr. Weil.—A weighed quantity of the sulphide or the ore in question is placed in a small flask fitted with a perforated stopper and a glass delivery tube. This tube plunges into a vessel containing an excess of a normal solution of copper, exactly measured, which is then mixed with an excess of ammonia until it becomes quite limpid and of a fine blue. An excess of hydrochloric acid is then rapidly poured into the flask containing the sulphide, which is placed in communication with the ammoniacal solution of copper. The sulphuretted hydrogen evolved is entirely precipitated as copper sulphide. The flask is heated until the vapours no longer occasion a precipitate

on entering the copper solution. The solution which remains blue from the excess of copper used is either separated from the precipitate by filtration or poured with it into a graduated jar, where it is made up to a given volume by adding the water used in washing the vessel. It is let settle and the copper is estimated in 10 or 20 c.c. of the clear blue solution. For this purpose the 10 or 20 c.c. are introduced by means of a pipette into a colourless glass flask and mixed with about 50 c.c. pure hydrochloric acid. It is heated to a boil and solution of stannous chloride (standardised with pure copper) is added by means of a burette until the liquid is completely decolourised. The volume of stannous chloride employed indicates the quantity of copper in the 10 or 20 c.c. taken, and consequently remaining in the entire volume of the blue liquid after part of the copper has been precipitated by the sulphuretted hydrogen. The difference between the quantity of copper thus found by titration and that originally contained in the volume of the normal copper solution employed gives the quantity or copper precipitated by the sulphur of the sulphides analysed. The quantity of sulphur contained in the portion of sulphide taken can be found by multiplying this difference by the coefficient 0·50393. It is useful to introduce a little granulated zinc into the flask containing the sulphide under analysis.

Researches on the Development of the Sugar-Beet.—Aimé Girard.—Not adapted for abstraction.

Revue Universelle des Mines, de la Metallurgie, &c., Vol. xix., No. 2, March and April, 1886.

Experiments on the Ignition of Coal-dust and Fire-damp.—C. Hilt.—The author concludes that the degree of tenuity of coal-dust plays a great part, but the result depends principally on the chemical composition of the coal. Coals containing from 16 to 24 per cent of volatile matter seem more dangerous than either poorer or richer qualites. The ignition is propagated between two distinct spaces, each containing either coal-dust or explosive gaseous mixtures, not only when they are placed in communication by a train of dust, but even when they are separated by a considerable distance free from fire-damp or coal-dust. The ignition of dust may be induced by an explosion of fire-damp as well as by a blast, and the explosion may be occasioned on firing a blast by electricity, as well as by a safety-match or a port-fire. With dynamite there is less danger, and with gun-cotton dissolved in nitro-glycerin practically none, if it is ignited by means of a cap of sufficient force.

Zeitschrift für Analytische Chemie. Vol. xxv., Part 2, 1886.

Determination of Nitrogen in Wine, Must, and Lees.—Dr. P. Kulisch.—The author recommends Kjeldahl's process as satisfactory.

Determination of Nitrogen by Kjeldahl's Method.—Dr. A. Kindell and F. Hannin.—The authors discuss the error occasioned by the mechanical projection of soda into the acid. They tried the safety tube filled with glass beads, as proposed by Pfeiffer and Lehmann. They found that the beads became very wet from the condensation of water, which spirted again on drying. A deeper stratum of beads was not found to be an improvement. They therefore kept the beads relatively dry by placing the tube containing them within a wider tube traversed by the steam. It was found that a stratum of beads 8 centimetres in height gave, when thus arranged, the required safety. The outer tube is 25 m.m. in diameter; the bead-tube is 10 to 12 m.m., and it is closed below by means of a cap of nickel wire gauze.

An Analysis of Gooseberry Wine.—Dr. L. Marquardt.—The proportion of potassa in gooseberry wine is about equal to that in grape wines. That of phosphoric acid is relatively smaller. Tartar is found by no means in trifling amounts, equal, in fact, to those found in many grape wines.

New Agent for Thickening Mineral Lubricating Oils.—Dr. L. Marquardt.

Determination of Phenol in Crude Carbolic Acid.—Julius Tóth.—This paper will be inserted in full.

New Method for the Quantitative Determination of Uric Acid.—J. B. Haycroft.—Apparently from an English source.

Behaviour of Plumbiferous Zinc on Re-melting.—K. Kraut.—The behaviour of plumbiferous zinc on melting renders it impossible to ascertain the mean proportion of lead in a large number of zinc plates by taking portions for analysis. No matter from how many plates borings or chippings are taken the result of the analyses will never authorise a conclusion as to the quantity of lead in the remaining plates.

Direct Determination of Chlorine in presence of Bromine.—Dr. G. Vortmann.—This paper will be inserted at some length.

Determination of Alumina by Titration.—Dr. K. J. Bayer.—The author refers to his former paper (vol. xxiv., p. 542). He states that the solutions must be very dilute, containing at most 0·1 alumina in 100 c.c. In titrating the reaction of the liquid is kept alkaline to near the end, keeping up a violent ebullition, and at last effecting the change of colour by means of a drop or two of normal sulphuric acid. The author now uses phenolphthalein as indicator in place of litmus. Attempts to precipitate alumina from its alkaline solutions by means of carbonic acid and then titrating the alkali remaining in solution, yielded, for the most part, unsatisfactory results, as the alumina on separation carries down with it much sodium carbonate, forming a peculiar double compound. If, however, a slow current of carbonic acid is passed into a dilute briskly boiling solution, keeping the flask in constant motion, aluminium hydroxide can be obtained free from soda, and the latter can be titrated in the ordinary manner. In the gravimetric determination of alumina in a sulphuric solution it must be remembered that these solutions often contain silicic, phosphoric, and arsenic acid, which are all carried down on precipitation with ammmonia, along with a part of the sulphuric acid. Even on re-dissolving the ammoniacal precipitate in hydrochloric acid and re-precipitating with ammonia in presence of much ammonium chloride, the alumina may still contain as much as 2 per cent of sulphuric acid.

Determination of Alumina in Aluminates.—E. B.—This paper will be reproduced in full.

Titration of Soda in presence of Alumina, Vanadium, and Tungstic Acid.—E. B.

Leidenfrost's Experiment as the Foundation of a New Method of Evaporating Liquids of all kinds to Dryness without Loss.—E. Bohlig.—This memoir will be inserted at some length.

A Thermo-regulator with an Electrical Bell-Signal.—A. Kalecsinsky.—This paper requires the three accompanying illustrations.

Analyses of Damson Brandy and Brandy from Pressed Grapes from South Hungary and the adjoining Regions.—M. Petrowitsch.—A memoir of no general interest.

Does every Wine contain Tartar?—M. Petrowitsch.—The author shows that certain wines from Kalowitz, indisputably genuine, contain no potassium bitartrate.

Alkaline Reaction of Well-Waters.—M. Petrowitsch.—In the county of Bacs in Hungary the water of more than 100 wells gave a permanent red colour with rosolic acid. Even the waters of the Danube and the Theiss in this region (the Hungarian soda-district) yield the same reaction.

Separation of Gold and Platinum from Tin, Antimony, and Arsenic in Qualitative Reaction.—R. Fresenius.—This paper cannot be intelligibly reproduced without the accompanying illustration.

Determination of Arsenic and Boric Acid in Mineral Waters.—R. Fresenius.—The contents of two large flasks of the water were mixed with a little sodium hypochlorite to oxidise the ferrous carbonate present, and were then acidified with hydrochloric acid. A little more ferric chloride was added, and then pure precipitated calcium carbonate in excess. The whole was repeatedly mixed, and the ochreous precipitate formed was allowed to settle. Along with ferric hydroxide it contains all the arsenic and phosphoric acid. It is filtered, washed, dissolved in hydrochloric acid of sp. gr. 1·10, the solution is placed in a retort, ferrous chloride is added, and the whole distilled down to a small residue. To this there is again added hydrochloric acid of the same strength, the liquid is again distilled, repeating this operation until the last distillate is no longer rendered turbid by sulphuretted hydrogen. The distillates are mixed, and on treatment with sulphuretted hydrogen yield fine yellow arsenic sulphide. It is dried on a filter at 100°, washed with alcohol, carbon disulphide, and alcohol, and weighed. All the reagents are previously tested in a similar manner. If the residues of the distillations are evaporated down so as to eliminate silica, then treated with hydrochloric acid and water and the liquid repeatedly evaporated with nitric acid, the phosphoric acid may be at once precipitated as ammonia phosphomolybdate.

Determination of Boric Acid.—36,350 grms. water are mixed with sodium carbonate until the solution is distinctly alkaline, and are then strongly concentrated. The precipitate separated out, consisting chiefly of alkaline earthy carbonates and ferric hydroxide, is filtered off, washed, and as it still contains boric acid it is dissolved in hydrochloric acid, and this solution, after dilution with water, is again precipitated at a boil with potassium carbonate. The filtrate, separated from the precipitate, is now mixed with the former and evaporated down to a damp saline mass. The boric acid is liberated by acidulation with hydrochloric acid and extracted with alcohol at 95 per cent. In this manner there is obtained an alcoholic solution containing all the boric acid. It is mixed with an excess of potassa, distilled off, and evaporated down to a small residue. This is treated in a similar manner twice more, and the small saline mass ultimately obtained is treated with boiling water, separated by filtration from a residue consisting mainly of magnesium hydroxide, and which, after washing with boiling water, is dissolved in a little hydrochloric acid, and the solution is precipitated with potassa and a little potasium carbonate. Thus a filtrate is obtained free from all alkaline earths and containing all the boric acid along with potassium hydroxide and a little silica in the state of alkaline salts. From this solution the boric acid is separated according to A. Stromeyer's method.

Definition of Normal Solutions and on Cl. Winkler's Proposal for Re-organising the Volumetric System.—W. Fresenius.—This paper will be inserted at some length.

Rapid Separation of Slimy Precipitates.—K. Zulkowsky.—This can be effected in many cases by shaking up the liquid containing the precipitate with ¼ volume of ether. The ether entangles the precipitate and carries it to the surface, so that the clear aqueous solution can be withdrawn. The precipitate is then obtained on allowing the ether to evaporate.—(*Chemiker Zeitung*).

Apparatus for Opening up Minerals in a Current of Chlorine.—R. Schelle (*Berg. & Hüttenmänn Zeitung*).—This apparatus cannot be intelligibly described without the accompanying cut.

Spectroscopic Studies on Radiant Matter.—W. Crookes.—From the *Annales de Chimie et de Physique*.

Contribution to Quantitative Spectroscopic Analysis.—Gerhard Krüss.—The author has investigated the narrowest width of the ocular slit available in determining the coefficient of extinction. From his determinations it appears that the lowest admissible limit for the contraction of the slit (with the telescope used by the author having a magnifying of the eye-piece of 13·4) is 0·263 m.m. Thus a spectral region of 3·524 m.m. is demarcated for the eye.

Vertical Polarisation Instruments.—H. Trannin, F. Schmidt, and Hænsch.—These appliances for the determination of sugar, described in *Dingler's Polyt. Journal* and in the *Zeitschrift für Instrumentenkunde*, are here briefly mentioned.

The Production of Hydrobromic Acid.—J. S. Stas.—The author gives a method for obtaining this compound, perfectly free from hydrochloric and hydriodic acids. For the details the reader is referred to the *Memoirs de l'Académie Royale des Sciences de Belgique*. The principle of the process is as follows:—The acid is evolved in the ordinary manner from red phosphorus, bromine, and water, but the bromine is previously freed from traces of chlorine and iodine by dissolving it in potassium bromide and distilling in contact with zinc oxide. The chlorine is converted into potassium chloride and the iodine is retained by the zinc oxide.

Determination of Traces of Sodium Chloride in presence of Potassium Chloride.—F. Röttger and H. Precht (*Ber. Deutsch. Chem. Gesellschaft*).—Twenty grms. of the finely powdered sample were covered in a beaker with 40 grms. alcohol at 90 per cent, often stirred with a glass rod, and after standing for half-an-hour mixed with ½ c.c. of a 10 per cent solution of potassium carbonate, which is added drop by drop, stirring constantly, and decanted three times. The residue remaining insoluble is washed several times on the filter, the filtrate is evaporated down in a platinum capsule, the residue is gently ignited and weighed. In the residue the potassium chloride is determined with platinum chloride, and the sodium chloride is calculated as the difference. If a rapid determination of sodium chloride in a 98 per cent solution potassium chloride is required the following method is recommended:—20 grms. of the finely-powdered sample are placed in a flask graduated to 110 c.c. (10 c.c. correspond to the bulk of the potassium chloride taken) filled up to three-quarters with alcohol at 90 per cent by weight, often shaken, and after half-an-hour is added ½ c.c. of a 10 per cent solution of potassium carbonate. The flask is filled up to the mark and shaken. When the liquid is clear 50 c.c. are drawn off with a pipette, evaporated down, and treated as above.

Sensitiveness of the Detection of Baryta or Sulphuric Acid.—Spencer Pickering.—From the CHEMICAL NEWS.

New Method for the Gravimetric Determination of Manganese.—H. von Jüptner (*Chemiker Zeitung*).—Already noticed.

Determination of Nitrous Acid in Nitrites.—L. P. Kinnicutt and J. U. Neff.—The authors modify the ordinary process as follows:—The nitrite in question is dissolved in at least 300 parts of cold water, and to this solution decinormal permanganate is added by degrees until the liquid takes a permanent red colour. Two to three drops of dilute sulphuric acid are added, and then an excess of permanganate. The dark red liquid is strongly acidified with sulphuric acid, heated to a boil, and the excess of permanganate is titrated back with decinormal oxalic acid.

Appointment.—Dr. A. B. Griffiths, F.R.S. (Edin.), F.C.S., &c., Lecturer on Chemistry and Metallurgy at the Technical School, Manchester, has been appointed Head Master and Lecturer on Chemistry and Physiology at the New School of Science of the City of Lincoln.

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THE CHEMICAL NEWS.

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NOTE ON THE ABSORPTION SPECTRUM OF DIDYMIUM.

By WILLIAM CROOKES, F.R.S.

IN a paper on "Radiant Matter Spectroscopy" (Part 2, Samarium)* I said that in fractionation of the didymium earths with ammonia—"After a time a balance seemed to be established between the affinities at work, when the earths would appear in the same proportion in the precipitate and in the solution. At this stage they were thrown down by ammonia, and the precipitated earths set aside to be worked up by the fusion of their anhydrous nitrates so as to alter the ratio between them, when fractionation by ammonia could be again employed."

That in most methods of fractionation a rough sort of balance of affinities beyond which further separation by the same method is difficult, appears to be a general rule. I have long noticed this action when fractionating with ammonia, with oxalic and nitric acids, and with formic acid. The valuable point which renders this fact noteworthy is that the balance of affinities revealed by fractionation is not the same with each method. It was in consequence of the experience gained in these different methods of fractionation that I wrote in my paper read before the Royal Society, June 10th last (CHEMICAL NEWS, vol. liv., p. 13), after saying that I had not been able to separate didymium into Dr. Auer's two earths, "probably didymium will be found to split up in more than one direction according to the method adopted."

In illustration of this I may mention that, although I have not split up didymium into the two earths, or groups of earths, which are described by Dr. Auer, other processes of fractionation give me, so to speak, other cleavage planes or lines of scission through the compound molecule didymium.

According to Dr. Auer a line in the well-known yellow band, close to the soda line, but less refrangible (w.l. about 579), is a component of the absorption spectrum of neodymium, and therefore, under all conditions, its intensity should follow the same variations as the other bands of neodymium in the blue (wave-lengths 482, 469, 444). Some of my didymium fractions, however, show that the line 579 does not follow the same law as the other bands I have named. Thus in a rather low fraction (+ 6) of the didymium earths from gadolinite and samarskite I found that the neodymium line 579 was of the same degree of blackness as the adjacent praseodymium line in the yellow (wave-length about 571), but the bands in the blue of neodymium had almost disappeared. In the adjacent fractions of didymium I was enabled, by appropriate dilution, to keep this set of bands in the yellow as a standard, of exactly the same intensity; it was now seen that in successive fractions the intensities of the other more refrangible lines belonging both to neo- and praseodymium varied greatly from strong to almost obliteration, the bands in the yellow always being kept of the same intensity.

Didymium prepared from a specimen of fluocerite differed somewhat from the other didymiums. Here the band 579 (ascribed to neodymium) was very strong, the band in the yellow of praseodymium (571) slightly weaker, and the bands in the blue of neodymium (482, 469, and 444) easily visible. On diluting the solution the bands in the blue of neodymium and the one component of praseodymium in the yellow (571) appeared to follow the same law in becoming fainter and fainter with dilution, whilst the other component band in the yellow of neodymium (579) remained unaffected.

It seemed to me that a possible explanation of this variation might be founded on the great strength of the bands in the yellow, and that the two fractions of didymium then under examination might differ only in the fact that one was slightly stronger than the other. To test this hypothesis I took the two fractions first experimented on, and putting each into a wedge-shaped cell of glass viewed them together in the spectroscope. *First*, I adjusted the wedges so that the group in the yellow appeared to be of the same intensity in each spectrum. On examining other parts of the spectrum it was seen that in one solution the bands in the green were tolerably strong and the bands in the blue scarcely visible, whilst in the other solution the bands in the green were very faint and those in the blue quite absent. *Secondly*, The position of the wedges was adjusted so that the bands in the green in each case should be of equal intensities. It was now seen that the alteration had greatly upset the balance of the bands in the yellow, the solution in which the bands in the green were faintest before now having much stronger yellow bands than the other. The explanation mentioned above therefore falls through, and I see no other way of accounting for the facts except on the supposition that by the mode of fractionation then adopted didymium had split up in a different manner to what it would have done if the method of Dr. Auer had been followed.

The colour of the different fractions of didymium nitrate varies from a dark rose-red at the more basic end (+17) to amber at the less basic end (+4). These variations in colour do not necessarily accompany a difference in the absorption-bands, for in one instance an amber and a rose-coloured salt were found to have almost identical spectra.

It would almost appear from these experiments, coupled with the facts I brought forward in last week's CHEMICAL NEWS (p. 14), that the "one band, one element" theory I lately advanced in connection with the phosphorescent spectrum of yttrium, may probably hold good in the case of the group of elements forming absorption spectra. According to this hypothesis, therefore, neodymium and praseodymium must not be considered as actual chemical elements, but only the names given to two groups of molecules into which the complex molecule didymium splits up by one particular method of fractionation.

* *Phil. Trans.*, Part 2, 1885, p. 706. A Reprint of this paper is also commenced in this No. of the CHEMICAL NEWS, p. 28,

ON THE ALLEGED REDUCTION OF FERRIC NITRATE BY MERCURY.

By GEORGE LUNGE.

MR. THOMAS BAYLEY asserts (CHEMICAL NEWS, vol. liv., p. 6) that ferric salts are reduced to ferrous salts in contact with mercury, and that therefore a "dark colour" or "pink to reddish tints" are produced when shaking acid containing iron in the nitrometer. After the experiment the liquid is stated to give a blue colouration with potassium ferricyanide.

I have tried this experiment, but I have failed to discover any reduction to ferrous salt. In the presence of a comparatively large quantity of ferric nitrate the liquid within the nitrometer assumed a raspberry tint, but never that well-known chocolate colour of a solution of NO in $FeSO_4$. The same liquid, after being diluted and partly neutralised with ammonia, and cooled down, gave no reaction with potassium ferricyanide. Of course, if the liquid were treated with that reagent just after being diluted, and therefore quite hot and containing an enormous excess of acid, it would turn blue with potassium ferricyanide; but no one acquainted with qualitative analysis will work that way.

In another experiment I purposely added less ferric nitrate to the nitrous vitriol, but sufficient to give a very strong reaction with potassium sulphocyanide after diluting and cooling. In this case no colour whatever was observed in the nitrometer. The above quantity is more than I have found in ordinary commercial nitrous vitriol. That any commercial nitrous vitriol should contain sufficient iron, in *any* shape, to dissolve a measurable quantity of NO, is an assumption for which no proof has been given, and which I shall not stop to discuss, having closed my account in this matter.

Zürich, July 8, 1886.

ON THE

ESTIMATION OF CAUSTIC AND CARBONATED ALKALI IN PRESENCE OF EACH OTHER.

By H. JOSHUA PHILLIPS.

The usual method, which involves two separate determinations of Na_2O in order to obtain the ratio of Na_2O present as hydrate to that present as carbonate, the author has found may be estimated fairly accurate in one and the same portion of sample taken. The method adopted depends upon the fact that recently precipitated $BaCO_3$ requires the same amount of normal acid to dissolve it as it would take to neutralise its equivalent of Na_2CO_3 in solution. One grm. (or more if the percentages are low) of the sample is taken and dissolved in a flask with 150 c.c. of distilled water, which has been recently boiled in order to eliminate any CO_2 that may be present. A clear solution of baric chloride is now added in just sufficient quantity to completely precipitate all the combined CO_2; it is then heated to incipient ebullition, and allowed to cool with the flask covered. After perfect precipitation of the baric carbonate has been insured, a few drops of an alcoholic solution of phenolphthalein are added, and the whole thoroughly mixed. NHCl is now run in gradually from a burette (stirring) until the last drop completely decolourises the solution, and the volume required noted. The NHCl is then run in until the whole of the baric carbonate is just dissolved, and then a few c.c. added in excess, the total volume used being noted. The excess of HCl is titrated back with normal Na_2CO_3 (boiling when near the neutral point to eliminate CO_2) until the pink tint is developed. The total quantity of normal acid used, minus the volume used for the neutralisation of the hydrate, will leave the quantity of acid equivalent to the carbonate present in the sample. Sulphuric acid is inadmissible in the titration, unless the theoretical quantity of baric chloride was used. In commercial lyes, sulphates being present, the whole of the precipitate produced by the $BaCl_2$ will not dissolve; but the $BaCO_3$ being not so fine as the $BaSO_4$, it will be readily discerned when the former has disappeared.

Coincident results have been obtained by this method to that quoted by Sutton in his "Volumetric Analysis," who also states that, after the hydrate has been determined in an aliquot part of the clear solution, the carbonate may be filtered off and titrated with nitric acid.

1, Park Place, Tredegar, Mon.

Determination of Santonine.—Ehlinger.—(*Chemiker Zeitung*). The author boils the plant repeatedly with ½ part slaked lime and abundance of alcohol at 0·935 sp. gr., distils off the bulk of the alcohol, and saturates the residual liquid with carbonic acid. The filtrate immediately freed from the calcium carbonate is evaporated to dryness and the residue is boiled with alcohol at 0·935 sp. gr., with the addition of animal charcoal. On expulsion of the alcohol the filtrate yields santonine in white crystals.—*Zeit.ch. f. Anal. Chemie.*

ON RADIANT MATTER SPECTROSCOPY.*

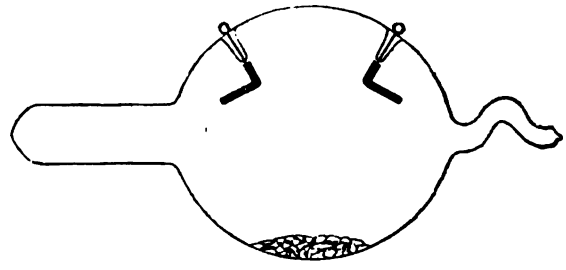
PART II.—SAMARIUM.

By WILLIAM CROOKES, F.R.S.

Introduction.

90. In the concluding sentence of the Bakerian Lecture which I had the honour to deliver before the Royal Society, May 31, 1883, I said that the new method of Radiant Matter Spectroscopy there described had given me not only spectrum indications of the presence of yttrium as an almost invariable, though very minute, constituent of a large number of minerals, but had likewise revealed signs of another spectrum-yielding element. I stated that I had repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band. That this second spectrum was not then new to me is shown by a paper sent to the Royal Society in 1881,† in which I described a double orange band occurring in the phosphorescent spectrum of an earth less frequently met with than the "pale yellowish coloured earth" (since identified as yttria) which gave me the "red, orange, citron, and green bands."

Fig. 1.



91. The method adopted to bring out the orange band is to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness. It is then put into a radiant-matter tube, of the form shown in Fig. 1, and the induction spark is passed through it after the exhaustion has been pushed to the required degree. The anhydrous sulphate thus left frequently shows the orange band in the radiant-matter tube, though before this treatment the original substance shows nothing.

The Elimination of Mercury Vapour from Vacuum Tubes.

92. The presence of mercury vapour is liable to interfere with the spectrum indications, and when working in an entirely new field, where the mutual reaction of bodies one on the other is the subject of the research, it is always desirable to reduce the unavoidable constants to a minimum. In a tube exhausted in the ordinary manner by the Sprengel pump more mercury vapour is present than is generally supposed. Unless the tube is exhausted and sealed off without loss of time, mercury diffuses through the connecting tubes, and soon gets into the vessel under experiment. It is not easily detected by the spectroscope so long as the tube remains cold, but when the passage of the current has warmed the glass and the metal poles the mercury lines become distinctly visible, and the same result is obtained at once when the tube is heated by a lamp.‡

* A Paper read before the Royal Society, June 18, 1885.

† *Proc. Roy. Soc*, vol. xxxii. (1881), p. 206.

‡ In incandescent lamps exhausted by means of a mercury pump, a peculiar blue phosphorescence is observed to fill the globe when the filament is raised much above its normal incandescence. This phenomenon has been examined and discussed by Mr. Edison in America and by Mr. Preece in England (*Proc. Roy. Soc.*, vol. xxxviii., No. 236, p. 219). During the course of my work on the manufacture of incandescent lamps I have frequently noticed the same effect. Examined

The following experiment illustrates this behaviour of mercury:—A small radiant-matter tube, having flat aluminium poles connected to platinum terminals passing through the glass, was sealed to the pump and quickly exhausted. An induction current was immediately passed through, and the light examined in the spectroscope. No mercury lines were detected. The tube was then heated strongly, the spectroscopic examination being continued: no mercury lines were seen. The apparatus was then allowed to rest for a day, and the experiments were repeated. In the cold no mercury lines could be seen, but on heating the tube they became distinctly visible.

93. The tube was then exhausted to the highest possible point, and sealed off. In the cold it was impossible to get an induction-spark through the tube,—it was absolutely non-conducting. However, on heating the tube with a Bunsen flame, keeping the coil going all the time, suddenly the current passed, lighting up the inside of the tube with a greenish blue light, in which the spectroscope showed strong mercury lines. On allowing the tube to cool it again became non-conducting, and the experiment could be repeated.

This shows that in a vacuum tube which is so highly exhausted as to be non-conducting there is plenty of mercury present to carry an induction current, only it is not in the form of vapour, but is condensed on the metallic poles or on the sides of the glass.

94. It is much more difficult than is generally supposed to keep mercury vapour from diffusing itself into the experimental tubes. Gold-leaf was packed loosely in a tube about 2 feet long, which was then interposed between the pump and the radiant-matter tube. This answered for a short time, but whilst it certainly kept back some of the mercury, it let much through.

For a long time I used a tube about 2 feet long, packed with coarsely-powdered sulphur. This is effectual at first, but there is a liability of sulphur vapour getting into the tube, and this might be as disastrous as mercury. The sulphur was therefore kept out by interposing another tube containing finely-divided copper. This, however, was not quite effectual: after a time mercury was found to have run the gauntlet of both sulphur and copper. It is of no use trusting to a solid reagent to absorb a gaseous body. Where the gas and solid meet there may be action, but some of the gaseous molecules are sure to get through without coming within the solid's sphere of attraction.

95. I finally adopted the following plan, which answers perfectly so far as my experiments have yet gone:—Sulphur is first prepared by keeping it fused at a high temperature till bubbles cease to come off, so as to get rid of water and hydrogen compounds. It is then allowed to cool, and is then pounded and sifted so as to get it in the form of granules averaging a millimètre in diameter. A glass tube, a centimètre in diameter and about 2 feet long, is lightly packed for half its length with this sulphur, and next about 2 inches of iodide of sulphur (I_2S_2) is added, and the rest of the tube is then filled up with sulphur. Ignited asbestos is packed in at each end to keep the sulphur from blowing out whilst the vacuum is being made, or from being sucked through when air is suddenly let in. This contrivance entirely keeps mercury vapour from passing through, since the iodide of sulphur holds its iodine very loosely, and fixes the mercury in the form of non-volatile red iodide. A glass tube containing finely-divided copper must follow in order to keep sulphur out. With this blockade interposed between the pump and experimental tubes I have been unable to detect mercury vapour in any of the tubes, whether in the cold or on heating them.

Mixed "Citron" and "Orange" Spectra.

96. Since the date of my last paper I have devoted myself to the task of solving the problem presented by the double orange band first observed in 1881. With the yttrium experience as a guide it might be thought this would not be a difficult task, but in truth it helped me little beyond increasing my confidence that the new, like the old, spectrum was characteristic of an element. The extreme sensitiveness of the test is a drawback rather than a help. To the inexperienced eye one part of "orange band" substance in ten thousand gives as good an indication as one part in ten, and by far the greater part of the chemical work undertaken in the hunt for the spectrum-forming element has been performed upon material which later knowledge shows does not contain sufficient to respond to any known chemical test. It is as if the element sodium were to occur in ponderable quantity only in a few rare minerals seldom seen out of the collector's cabinet. With only the yellow line to guide, and seeing the brilliancy with which an imponderable trace of sodium in a mineral declares its presence in the spectrum, I venture to think that a chemist would have about as stiff a hunt before he caught his yellow line as I had to bring my orange and citron bands to earth.*

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces;" and when an analysis adds up to 99·99, the odd 0·01 per cent is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·99 per cent constitutes the impurity and this exiguous 0·01 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and the solubility of nearly all precipitates in water or in ammoniacal salts when present in traces only. What is here meant by "traces" will be better understood if I give an instance. After six months' work I obtained the earth didymia in a state which most chemists would call absolutely pure, for it contained not more than one part of impurity in five hundred thousand parts of didymia (131). But this one part in half a million profoundly altered the character of didymia from a radiant-matter-spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another six

in the spectroscope the phosphorescent light filling the globe shows the mercury lines strongly. In order to examine this phenomenon more closely the following experiments were tried:—An incandescent lamp with fine carbon filament which had been plated up in vapour of carbon tetrachloride was placed in one of the sides of a Wheatstone bridge and connected with a dynamo-electric machine, where by means of a suitable rheostat it could be raised to any desired degree of incandescence. A spectroscope was adjusted so that the slit was opposite the rarefied space between the two limbs of the filament. With an E.M.F. of 64·5 volts, a current of 0·97 ampère, and a light of twenty candles, no lines were visible in the spectrum; on increasing the volts to 73·6 the current became 1·15 ampères, and the c. p. 43. At this stage flashes of blue phosphorescence filled the bulb at regular intervals of about ten seconds, and at the same instant the mercury lines were seen in the spectroscope, $\frac{1}{\lambda s}$ 2984, 3006, 3354, and 5265 being most prominent. On increasing the E.M.F. to 81·3 volts the current became 1·28 ampères, and the light seventy-four candles; the flashes of phosphorescent light became more frequent, pulsating very regularly once every three seconds, and at each flash showing the mercury spectrum strongly. The E.M.F. was next increased to 99·7 volts, and the ampères to 1·83; at this point the light was equal to 172 candles. The flashes of light became more and more frequent, rising quickly from once in two seconds till they occurred too rapidly to count, and the blue phosphorescence became continuous and seemed to fill the globe. The mercury spectrum at this stage was permanent, and most of its lines could be detected. The flashes of light were probably owing to some such action as this:—The hot filament offering a considerable resistance to the passage of the current, the long length of insulated wire in the circuit (about half a mile, including the lamps used for house-lighting) charged up like a condenser, and then at intervals discharged through the highly rarefied vapour in the bulb.

* So recently as the year 1880 a high authority on blowpipe chemistry seriously argued that the yellow-coloured flame "which is ascribed to sodium" is not caused by that metal, but is due to "chemical water."—(CHEMICAL NEWS, vol. xli., p. 159, April 2, 1880).

months' extra labour to eliminate these final "traces" and to ascertain the real reaction of didymia pure and simple (131).

For a long time the "citron-band" and the "orange-band" spectra were confounded. That they were due to two different states or kinds of matter was not easily decided, since in all the early experiments I was dealing with a mixture; consequently the spectra obtained were not only mixed, but differed considerably in the relative intensities and faintness of the different lines (146).

97. At last having separated yttria and obtained its spectrum pure (71), the characteristic lines in the other spectrum or spectra could be provisionally mapped out by difference, and a systematic hunt was instituted for the new "orange-band" substance, which to avoid periphrasis was termed *x*. Naturally my thoughts turned to samarskite and the yttria earths. A wide, prolonged survey over every available substance had convinced me that the number of bodies giving a discontinuous phosphorescent spectrum is extremely limited, and to be counted on the fingers of one hand; and having satisfactorily mated one of these spectra to yttria it became in the highest degree probable that the twin spectrum should belong to one of the nearest chemical associates of yttria.

Chemistry of the "Orange-band" forming Body.

98. At first it was necessary to take stock, as it were, of all the facts regarding *x* which had turned up during the search for the orange band. In the first place *x* is almost as widely distributed as yttria, generally occurring with the latter earth. Sometimes, however, the orange band was strong where the citron band was almost or quite absent. It is almost certainly one of the earthy metals, as it occurs in the insoluble oxalates, in the insoluble double sulphates, and in the precipitate with ammonia. It is not precipitated by sodic thiosulphate, and, moreover, it must be present in very minute quantities, since the ammonia precipitate is always extremely small, and as a rule *x* is not found in the filtrate from this precipitate.

99. At this stage of the enquiry the chemical reactions of *x* were much more puzzling than with yttria. At the outset an anomaly presented itself. The orange band was prone to vanish in a puzzling manner. Frequently an accumulation of precipitates tolerably rich in *x* was worked up for purposes of concentration, when the spectrum reaction suddenly disappeared, showing itself neither in precipitate nor filtrate (3, 101, 108, 115); whilst on other occasions, when following apparently the same procedure, the orange band became intensified and concentrated with no apparent loss. The behaviour of the sulphate to water was also very contradictory; on some occasions it appeared to be almost insoluble, whilst occasionally it dissolved in water readily (115).

100. For some time I debated whether the orange-band spectrum might not be a mere modification of the yttrium spectrum induced by the presence of some extraneous body. We know that yttria *per se* has little or no phosphorescence (75), that this power chiefly resides in the ignited sulphate. Might it not happen that some other earth with molecules peculiarly sensitive to the longer vibrations would confer upon yttria some of its sensitiveness to the red end of the spectrum?

It would be too much like a repetition of my paper on the yttrium spectrum quest were I to detail the numerous experiments and false starts with samarskite, orangite, thorite, strontianite, cœlestine, perofskite, cerite, coral, &c.; but I may be permitted to extract from an enormous mass of chronicles which must remain unpublished, some few experiments which will usefully emphasize what I may call the nodal points in this research.

"*X*" *from Samarskite.*

101. It was to be expected that samarskite would contain *x*. It occurred, however, very little in the yttria group, but was found with the decipia residues (47, 49), or the earths forming, with potassium, insoluble double sulphates,—ceria, lanthana, didymia, decipia, samaria, together with a little thoria and zirconia. These residues were dissolved in hydrochloric acid, precipitated with ammonia, washed till free from potassic salts, re-dissolved, and precipitated as oxalates. The filtrate was set aside in Winchester quart bottles, and after standing for some weeks a further quantity of insoluble oxalates was found deposited at the bottom of the bottles. These were collected, and appeared to be very rich in *x*; but on attempting to work them up vexatious anomalies constantly started up: suddenly the orange band would disappear, and, after being lost sight of for a week or two, would return in a manner equally unaccountable (3, 99, 108, 115).

Thorite and Orangite.

102. Early in my research thorite and orangite (26) had given a brilliant spectrum, afterwards identified with that of yttria (70). When hunting for *x* some of the insoluble double sulphates from these minerals (32) were treated like the samarskite double sulphates to remove potassium (101), and examined in the radiant-matter tube. Here, also, was found the orange-band spectrum, quite different from the yttrium spectrum of the soluble sulphates; but, as usual, it behaved in a most capricious manner.

Perofskite.

103. An American friend, Mr. George F. Kunz, with great kindness sent me some pounds' weight of the rare mineral perofskite (calcic titanate) in fine crystals, from Magnet Cove, Arkansas, together with a large number of specimens of associated minerals from the same locality. The perofskite was found to be richer in *x* than any mineral yet examined. At great sacrifice of material a small portion of an earthy body was obtained giving the orange-band spectrum more brilliantly than I ever had seen it before. Analysis failed to detect anything in it but lime (5, 9), the flame spectrum showed lime, and the atomic weight came out RO=55·3, CaO being 56.

Calcite.

104. Mr. Lettsom, understanding I was engaged in quest of an unknown body supposed to be associated with calcium, most kindly sent me specimens of rare and curious minerals; and through his good offices Professor Albin Weisbach presented me with an extensive set of calcites; these, prior to the invention of the spectroscope, had been measured by Professor A. Breithaupt, who, owing to the discordant measurements, held what is known as "calcium" to consist of two or more allied elements, which as yet chemists were unable to separate.

These calcites were treated as usual, and examined most carefully in the radiant-matter tube. In one of them only was a trace of yttria found, but the orange-band spectrum was very faintly seen in six of the thirteen specimens. The others shone with the usual greenish blue phosphorescence of calcic sulphate, giving no lines or bands in the spectrum.

I am also indebted to M. Lettsom for a specimen of calcite from Branchville, S. Carolina, which, when heated, has the curious property of glowing strongly with a golden yellow light showing a faint continuous spectrum. In the radiant-matter tube the phosphorescence was very brilliant, but there was no discontinuity in the spectrum, only a concentration of light in the red portion.

Dolomite.

105. Another curious mineral, for which I am also indebted to Mr. Lettsom, is a granular dolomite from Utah. When scratched with a knife or struck with a pick it emits so strong a phosphorescent red light that the miners call it Hell-fire Rock. By itself in the radiant-matter tube it brightly phosphoresces with a reddish light, showing no bands, but a concentration of light in the red. Treated with sulphuric acid in the usual manner, and then

examined in a vacuum tube, a similar continuous spectrum was observed. Chemical analysis showed that it was a nearly pure double calcic and magnesic carbonate, with a little iron, alumina, and phosphoric acid.

Amongst other minerals found to give the orange-band spectrum I may mention zircon, euxenite, tyrite, fergusonite, rhabdophane, cerussite, apatite, galliferous blende, argentiferous galena, anglesite, harmotome, allanite, cerite, magnesite, oolite from Bath, &c.

Coral.

106. In my former paper (88) I mentioned that a specimen of pink coral contained about a half per cent of yttria, judging from the very strong yttrium spectrum it gave in the vacuum tube. Professor Martin Duncan has identified this specimen as a *Gorgonia* of the genus *Melithæa*. Another recent coral, *Mussa sinuosa*, gave equally strong indications of yttrium. By the kindness of Professor Duncan I have since been enabled to submit a large number of corals to spectrum examination in the radiant-matter tube. Nearly all showed more or less discontinuity in their phosphorescent spectra, but as in the yttrium spectrum research I obtained only two specimens giving a brilliant yttrium spectrum, so in the present quest I have found only two corals giving a strong orange-band spectrum. One is a *Pocillopora damicornis*, from Singapore and most of the Pacific Islands which have reefs, one of the old group of tabulate corals. A fragment of this coral, treated with sulphuric acid and examined in the radiant-matter tube, gave as brilliant an orange-band spectrum as I had ever seen. The other is of the species *Symphyllia*, close to *Mussa*, a reef-builder from the same locality as the *Mussa* which gave so much yttria.

Sea-water.

107. These results induced me next to try sea-water. Ammonic oxalate and hydrate gave a white precipitate, which was filtered off and washed. The oxalate was then ignited, dissolved in nitric acid, and the solution supersaturated with ammonia and boiled. The resulting precipitate, tested in the radiant-matter tube, showed the orange-band spectrum very well.

"X" in Strontium Minerals.

108. The orange-band spectrum in the radiant-matter tube at first sight bore a close resemblance in the red region to the flame spectrum of strontium; the two spectra therefore were examined together, and on comparing them a near coincidence was observed between two lines in the orange, Was it possible that the sought-for element was strontium?

This led to an examination of the strontic nitrate used in the flame reaction. When converted into sulphate and tested in the radiant-matter tube the experiment succeeded only too well. The orange-band spectrum came out brilliantly.

Other commercial strontium compounds were now tested. Yttria was found almost universally, but the orange band was capricious; the nitrate generally showed it well, caustic strontia sometimes, chloride as a rule not at all. These were from different makers. The source was enquired for, and in a few weeks my laboratory was filled with large specimens of Gloucestershire, Italian, and Sicilian cœlestine, and Scotch, Italian, and German strontianite, together with waste-products, mother-liquors, and every commercial salt of strontium. The kindness of the manufacturers was great, and I regret that the outcome was not more notable.

Italian cœlestine showed a good orange-band spectrum when crushed and examined in the tube without any chemical treatment. After getting the mineral into solution by fusion with sodic carbonate, &c., the x could be concentrated by fractionally precipitating with alkaline carbonates (coming down in the first fractions). The sulphate produced from this precipitate also showed the desired spectrum.

This sulphate was digested for some time in warm ammonic carbonate, and now the old distressing anomalies recommenced. On most occasions, when working roughly on a scale of a few grammes, all the x was found in the filtrate on evaporation and ignition. When, however, I took identically the same material, and worked it up more carefully, in pounds or hundredweights, it sometimes gave nothing at all, sometimes only a *ridiculus mus* on the smallest-sized filter, got from a mountain of raw material. This was at first accounted for by the want of homogeneity of the mineral. The real explanation, however, was not discovered till long after (115).

A quantitative estimation was attempted of the amount of x substance got from Italian cœlestine: 630 grms. gave 1·525 grms., or 0·24 per cent. Analysis showed this to be chiefly strontic sulphate, and the atomic weight of the metal was close to that of strontium.

(To be continued.)

THE AMOUNT OF MOISTURE WHICH SULPHURIC ACID LEAVES IN A GAS.

By EDWARD W. MORLEY.

BERZELIUS and Dulong,* about 1820, and Erdmann and Marchand,† about 1842, employed calcium chloride in determining the atomic weight of oxygen, and were probably not aware that it leaves unremoved a comparatively large amount of water. Dumas,‡ in 1842, and Pettenkofer,§ in 1862, mentioned as well known, the fact that calcium chloride will not dry a gas as completely as sulphuric acid. Favre,‖ in 1844, proved that sulphuric acid at ordinary temperatures dries a gas so completely that neither sulphuric acid at −17° C. nor phosphorus pentoxide will absorb a sensible quantity of moisture from 40 litres of gas, nor even from volumes "bien plus considérables." He also attempted¶ in a most ingenious way to determine whether a gas dried by either of these agents was absolutely dry. He passed air dried as perfectly as possible over red-hot copper, and then again through a drying tube. In one experiment, 148 litres of air were reduced to 117 litres of nitrogen, and deposited 0·0025 grm. of water; in the other, 110 litres of air were reduced to 87 litres of nitrogen, and deposited 0·0015 grm. of water. Hence he concluded that a litre of gas dried by sulphuric acid or phosphoric oxide contained not more than 0·00006 or 0·00008 grm. of water.

He also proved** that no other force than the tension of the vapour of water causes it to be retained in certain gases. Favre further proved,†† as did Regnault in 1845,‡‡ that drying tubes of no large dimensions are required to utilise the whole drying power of the drying agent with which they are filled. In 1864, and again in 1865, Fresenius§§ published experiments, which, if they were affected by no source of error at that time unsuspected, would show that sulphuric acid leaves one or two decimilligrms. of moisture in a litre of gas. But in 1876, Dibbits'‖‖ published experiments in which precautions were taken against the leakage of moist air through caoutchouc connectors, which showed that 308 litres of air dried by sulphuric acid at ordinary temperatures gave up but 7 decimilligrms. of moisture to phosphorus pentoxide.

Dibbits also proposed a method for solving the remain-

* *Ann. Chim. Phys.*, 2nd Series, vol. xv., p. 388.
† *Journ. Prakt. Chemie*, vol. xxvi., p. 464.
‡ *Ann. Chim. Phys.*, 3rd Series, vol. viii., pp. 193, 210.
§ *Lieb. Ann. Supp.*, vol. ii., p. 29.
‖ *Ann. Chim. Phys.*, 3rd Series, vol. xii., p. 223.
¶ *Ibid*, vol. xii., p. 225.
** *Ibid.*, vol. xii., p. 227.
†† *Ibid.*, vol. xii., p. 228.
‡‡ *Ibid.*, vol. xv., p. 152.
§§ *Zeitschr. Anal. Chem.*, vol. iv., p. 180.
‖‖ *Ibid.*, vol. xv., p. 160.

ing question: How much moisture is left in a gas dried by phosphorus pentoxide? He proposed to evolve a gas of which we might be certain that it contained no water, to pass it into water, and then to dry it with phosphorus pentoxide. He suggested the evolution of dry oxygen by heating fused potassium chlorate. Whether perfectly dry oxygen could be thus obtained remains to be seen; the task of keeping up a suitable current of oxygen till a few hundred litres shall pass the absorption tubes would involve a good deal of labour.

Desiring to know the amount of water which sulphuric acid or phosphorus pentoxide fails to remove from a gas, I succeeded in devising a method which has made the solution of the problem easy. It permits the determination of the absolute amount of moisture left in a gas by any drying agent; the maintaining a slow current of air for days or weeks demands attention for only some five minutes each day, so that very large volumes of air may be used, at small velocities, and even if the residual moisture is as little as a hundredth or a thousandth of a milligrm. in a litre, it may be determined with any needed accuracy.

I devised the method with the intention of applying it first to phosphorus pentoxide. But in the third number of the *Zeitschrift fur Analytische Chemie* for 1884, Mathesius made certain statements about the use of sulphuric acid in drying tubes, in consequence of which I first undertook the study of the absolute amount of moisture left in a gas by this drying agent.

The paper of Mathesius raised a preliminary question which had to be answered. He found that certain drying tubes filled with sulphuric acid, of specific gravity 1·84, when used to absorb moisture as in organic analysis, lost weight at the rate of five or more decimilligrms. an hour. This statement must be taken as referring to sulphuric acid supposed to be pure; because a statement that impure sulphuric acid contained some volatile impurity would hardly be worth publication; and also because, in order to lessen the loss of weight in his drying tubes, Mathesius diluted the acid somewhat, probably supposing that the vapour of sulphur trioxide escaped and occasioned the loss of weight.

It is difficult to believe that either water or sulphur trioxide can be given up by pure sulphuric acid to a current of gas in any such quantity as Mathesius observed. Regnault* determined the tension of the vapour of water given off at 20° C. by sulphuric acid of the formula SO_3+2H_2O. This is 0·15 m.m., so that a litre of absolutely dry air passing through such acid would take up at this temperature 0·16 milligrm. of water. He gives no results for acid more concentrated than this; but from a comparison of the results for more dilute acids it is difficult to believe that an acid containing half a molecule of water and one molecule of the monohydrated acid would give up to a litre of absolutely dry air as much as the twentieth of a milligrm. of water at ordinary temperatures.

And as to the evaporation of sulphur trioxide from sulphuric acid: Dumas† passed 20 litres of air through pure sulphuric acid, and into solution of barium chloride, which preserved "une limpidité absolue." But if the loss of weight observed by Mathesius was due to the escape of sulphur trioxide, Dumas should have obtained not only a visible but a weighable precipitate.

But while we may dismiss the idea that sulphur trioxide escapes from sulphuric acid in drying tubes in ordinary conditions in any such quantities as several decimilligrms. an hour, it was necessary for the determination of the absolute amount of moisture left unabsorbed by sulphuric acid that the amount of sulphur trioxide volatilised should be accurately determined. For this purpose I made several experiments. In one of them, a wash-bottle and a Winkler's absorption tube were filled with pure sulphuric acid. This acid I distilled from a pure acid, rejecting the first and the last fifth. Its specific gravity at 22° and at 16·8° C., compared with water at 4°, weights being reduced to a vacuum, and the thermometer being corrected for error of zero point, was found to be 1·8344 and 1·8394. A current of air was aspirated through a gas-meter, through the wash-bottle of acid, through the absorption tube with acid, through an empty tube two metres long, through a plug of glass-wool, and through an absorption tube with pure water. The acid in the absorption tube occupied about two metres and a half; the water in the other absorption tube occupied about a metre. The parts of the apparatus were fused together. When 6800 litres had passed, not too rapidly, the sulphuric acid in the water was determined as barium sulphate, and found to be 3·1 milligrms. In a second experiment at a somewhat lower temperature, 0·7900 litre were passed and 2·5 milligrms. of acid were found in the second absorption tube. Several experiments were made in which air passed, at the rate of two litres an hour, into a solution of barium chloride; in which experiments neither myself nor Dr. Spenzer, my assistant, could detect any trace of a precipitate till the third day.

With the degree of approximation thus far obtained, therefore, we may conclude that a litre of air passed through sulphuric acid of the specific gravity of 1·84 will take up something like the two-thousandth or three-thousandth part of a milligrm. of sulphur trioxide at ordinary temperatures.

This being determined, the way was clear to determine the absolute amount of moisture left in a gas by sulphuric acid. To Liebig's potash bulbs I fused a sixth bulb, connected with the others by a capillary tube of so small bore that when a vacuum was maintained at one end, one or two cubic centimetres of air would pass through it in a minute. In this sixth bulb I placed sulphuric acid so diluted with water that air passing through it would take up a certain small amount of water. In the bulbs which belonged to the original apparatus was placed sulphuric acid of specific gravity 1·8381 at 18° C., compared with water at 4° C., weights and thermometer being corrected.

In use, a partial vacuum was maintained in the five bulbs containing strong acid, while the dilute acid was in contact with air at ordinary pressure. Air in passing from the dilute acid through the constriction towards the strong acid would therefore expand a number of times depending on the pressure in the partial vacuum. The air before entering the dilute acid was made as dry as sulphuric acid can render a gas; it took up water from the dilute acid; it was expanded; the increased volume was made as dry as sulphuric acid can render a gas.

Let us imagine, for the sake of clearness, that the expansion in passing the constriction was ten times, that five litres of air entered the dilute acid, and that therefore fifty litres passed out of the strong acid. Let us also make two alternative suppositions in order; first, that sulphuric acid makes a gas perfectly dry, and second, that it leaves a hundredth part of a milligrm. of water in a litre of gas.

If, according to the first supposition, sulphuric acid makes a gas perfectly dry, the five litres of dry air which enter the six-bulb apparatus carry into it no water. In the sixth bulb they take up a small quantity of water. Passing the constriction, they become fifty litres. The sulphuric acid makes the fifty litres perfectly dry, and no water is carried out of the apparatus. Therefore the only effect changing the weight of the apparatus is the escape of sulphur trioxide, the amount of which is approximately known.

But, secondly, if sulphuric acid leaves a hundredth of a milligrm. of water in a litre of gas, the five litres of air entering the apparatus carry into it one-twentieth of a milligrm. of water. In the sixth bulb, more water is taken up. The five litres expand to fifty. Now the drying such a gas as air is simply a process of reducing the vapour tension of the accompanying vapour of water. One litre of air dried by sulphuric acid will contain water

* *Ann. Chim. Phys.*, 3rd Series, vol. xv., p. 179.
† *Ibid.*, 3rd Series, vol. iii., p. 204.

possessing a certain tension, whatever be the pressure of the air. At least Regnault proved this to be true within one per cent. The fifty litres of air will therefore carry out ten times as much moisture as the five litres brought in. Neglecting for a moment the evaporation of sulphur trioxide, the apparatus will lose nine-twentieths of a milligrm. in weight. Conversely, if we knew the expansion to be ten times, and the entering air to be five litres, and the loss of weight to be 0·45 milligrm., we could compute the water remaining in each litre to be 0·01 milligrm.

In applying this principle, it was necessary to avoid errors due to leakage of moist air into the apparatus during the long time through which an experiment lasted, and to provide for weighing the six-bulb apparatus so accurately as to make certain the detection of a total effect of a few tenths of a milligrm. I secured sufficient accuracy in weighing by using as a counterpoise an apparatus of the same shape and same kind of glass, filled with the same acid, and interposed in the same current of air. To these I fitted ground glass caps as accurately as I could, so that I could leave the two apparatus on the balance for several days without any change in their relative weights; of course after applying corrections for the state of the barometer and thermometer.

I also fitted to the two apparatus just named, a third, which prevented the diffusion of moist air backward from the vacuum, and a fourth which dried the air before it entered the first and second apparatus, all, to each other, by glass tubes with joints carefully ground which were made tight with a fat from which all matter volatile at common temperatures had been removed. In this way, I could leave the apparatus for weeks with the certainty that moist air could not enter the apparatus.

The measure of the volume of air which enters the apparatus and of the expanded volume which leaves it is easy. The third drying tube which prevents the diffusion of moist air backward was fused, together with a barometer gauge, to a tube leading to an air-tight reservoir of 54·1 litres capacity. When all the drying tubes were in place, the pressure in the reservoir was reduced to such a fraction of an atmosphere that the air passed through the last five bulbs of the six-bulb apparatus at the rate of about two litres an hour. This pressure was observed on the barometer gauge. Call the pressure a. On the next day, or sometimes in twelve hours, the pressure was again observed. Call the second pressure b. The pressure in the reservoir was then again reduced, and the apparatus was ready for another day of action.

Now, disregarding variations of temperature and supposing the barometer constant, remembering that the expansion of the air takes place so slowly that no cooling effect is sensible, we can easily compute the volume of rarefied air which has passed out of the six-bulb apparatus while the pressure has increased from a to b. For this purpose put

w = the weight of the air which would pass through the constriction in the unit of time, if a perfect vacuum were maintained on one side, and the barometric pressure on the other.
x = the pressure in the reservoir.
h = the height of the barometer, assumed constant.
t = the time.
u = the weight of air in the reservoir at the pressure x.
c = the capacity of the reservoir.
l = the weight of a litre of air at the temperature and pressure of the air during the experiment.
V = the volume of rarefied air passing out of the apparatus while the pressure rises from a to b.

The weight of air passing out of the six-bulb apparatus in the unit of time, when the pressure in the vacuum is not zero, but x, may be written $wf(x)$. At normal pressure, its volume would be $\frac{w}{l} f(x)$, but under the pressure x, its volume would be $\frac{h}{x}\frac{w}{l} f(x)$, and we therefore have $dV = \frac{h}{x}\frac{w}{l} f(x)dt$. Also it is obvious that $\frac{x}{h} = \frac{u}{cl}$, so that $du = \frac{cl}{h} dx$; and obviously $du = wf(x)dt$. From the last two equations we find $dt = \frac{cl}{hwf(x)} dx$; and substituting this value we get $dV = c\frac{dx}{x}$.

Therefore—

$$V = c\int_{x=a}^{x=b} \frac{dx}{x} = c \log \frac{b}{a}.$$

This is the volume of rarefied air which passes the constriction while the pressure rises in the reservoir from a to b. Its volume on entering is computed in an obvious manner.

I have so far made three experiments, as follows:—

	I.	II.	III.
Air entering apparatus = n..	27 l.	23 l.	58 l.
Mean temperature = t.. ..	16° C.	15° C.	19° C.
Air leaving apparatus	286 l.	228 l.	757 l.
Excess leaving	259″	205″	699″
Litres an hour	1·6″	1·4″	1·2″
Dilute acid, specific gravity	1·707	1·707	1·566
Vapour tension of water from such acid at temperature t..	M.m. 0·48	0·43	1·85
M.grms. water taken up by n litres air, at t (computed)..	M.g. 13	10	106
Specific gravity strong acid at 18°/4°	1·8381	1·8381	1·8388
Loss, decimilligrms.	5½	4½	18

Experiments 1 and 2 were parts of the same experiment which was interrupted to see if the loss of weight were proportional to the amounts of air in the line marked "excess leaving." In all three experiments, 1163 litres more passed out than entered the apparatus, the sum of the losses in weight is 2·8 milligrms. The amount of sulphur trioxide which escaped may be computed at 0·4 milligrm. The remaining 2·4 milligrms. is the weight of aqueous vapour carried out of the apparatus by 1163 litres of air. The quantity subtracted is affected with some uncertainty, since the air used in the experiment on the evaporation of sulphur trioxide was not purified from organic matter, and there may have been reduction of the acid to the dioxide, and reoxidation to sulphuric acid. But with the approximation so far obtained, the water which strong sulphuric acid fails to remove from a slow current of air is about the four hundred and fiftieth or five hundredth part of a milligrm. in a litre of air.

Dibbits* showed that 308 litres of air dried by sulphuric acid gave up 0·7 milligrm. to phosphorus pentoxide. It is curious that this is the quantity which my experiments show to be left by sulphuric acid in that quantity of air. The obvious inference may be true, but is not safe. I shall hope to repeat these experiments on the evaporation of sulphur trioxide from sulphuric acid with purified air, and those on residual moisture left in a gas by the acid with some form of apparatus permitting more accurate weighing than Liebig's bulbs.—*American Journal of Science*, No. 176.

Action of Heat upon the Acetones.—MM. Barbier and Roux.—The authors have experimented upon ordinary acetone, benzophenone, and acetophenone. The characteristic action of heat upon these three acetones consists in determining the separation of carbon monoxide and the liberation of the fundamental hydrocarbon groups. —*Comptes Rendus.*

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* *Zeitschr. Anal. Chem.*, vol. xv., p. 160.

ON THE

ESTIMATION OF ACETIC ACID IN LIQUIDS CONTAINING ORGANIC MATTER, BY DISTILLATION.

By H. W. WILEY.

Having had occasion to make an examination of some samples of kumys, I was led to enquire whether any other acid except lactic was present. The microscope showed the presence of bacteria aceti, and thus established the presence of acetic acid.

In a substance so complex as kumys the estimation of a minute quantity of acetic acid is a matter of great difficulty. In order to accomplish it in at least an approximate manner I determined to try the method of Duclaux,* which rests upon the assumption that acetic acid in a solution subjected to distillation gives a definite percentage of its weight in given successive portions of the distillate. When ten-elevenths of the original liquid has been distilled the portion of the acid given off amounts to 79·8 per cent.

Mr. A. H. Allen,† who quotes M. Duclaux's results, states that in the only trial he has made of the method, viz., the estimation of the acid in acetate of lime, the quantity obtained was considerably below the amount claimed by M. Duclaux.

This fact caused me to suppose that the actual percentage of acid distilled depended largely on the percentage present, as well as on the total amount of the distillate. In order to submit this idea to the test of experiment I made a large number of distillations of pure fresh milk, to which varying amounts of acetic acid of known strength were added.

I found that in order to have a liquid residue of 10 to 15 c.c. left in the retort when 100 c.c. of milk were used and the distillate equalled 100 c.c. in volume, it was necessary to add to the milk the dilute acid and enough water to bring the total volume up to 130 c.c. After numerous trials I find that at least 15 c.c. of liquid residue should remain in the retort at the end in order to prevent the casein, sugar, &c., from burning.

The quantity of liquid remaining in the retort was determined by pouring the whole of the residue in a linen filter and measuring the volume of the filtrate. In the following experiments the residual liquid varied between 14 and 16 c.c. in quantity. A solution of fifth normal acetic acid was used, of which 1 c.c. contained 0·012 grm. of pure acid.

Since the amount of acetic acid in sour milk or kumys can never be very great in quantity the trials were made with very weak solutions.

The quantities of fifth normal acid used varied from 5 to 30 c.c. in a volume of 130 c.c. A large number of distillations were made in various attempts to prevent the frothing of the acidulated milk and the consequent transfer of portions of it to the distillate. The best methods of preventing frothing will be given hereafter.

Method Employed.

In each case 100 c.c. of milk were used. To this the acetic acid solution was added and then enough water to make the volume up to 130 c.c. Each 10 c.c. of the distillate was titrated separately by N/100 soda, using phenolphthalein as indicator.

Results with 5 *c.c.* N/5 $HC_2H_3O_2$.

Percentage acid present by weight 0·044. The mean of a large number of distillations showed that the total acid distilled in 100 c.c. when the above amount was present was only 7·33 per cent of the whole. The quantity given off in each 10 c.c. of distillate as well as the total is given below:—

1.	10 c.c. of distillate		0·33 per cent
2.	10	„	0·33—0·66
3.	10	„	0·39—1·05
4.	10	„	0·35—1·40
5.	10	„	0·40—1·80
6.	10	„	0·59—2·39
7.	10	„	0·60—2·99
8.	10	„	0·90—3·89
9.	10	„	1·25—5·14
10.	10	„	2·19—7·33

It may be doubted whether it is worth while to try to estimate so minute a portion of acid as 0·044 per cent, but even this amount can be detected as a trace in a mixture of it with lactic acid, when the latter does not exceed 0·30 per cent, as will be shown subsequently.

Results with 10 *c.c.* N/5 $HC_2H_3O_2$.

10 c.c. fifth normal acetic acid contain 0·12 grm. anhydrous acid.

In 135 grms. this is 0·089 per cent.

The amount of total acid present coming over with each successive portion of 10 c.c. distillate was as follows (mean of 100 titrations):—

1.	10 c.c.	0·89 per cent
2.	10	1·12— 1·91
3.	10	1·27— 3·18
4.	10	1·31— 4·49
5.	10	1·42— 5·91
6.	10	1·59— 7·50
7.	10	1·87— 9·37
8.	10	2·20—11·57
9.	10	2·69—14·26
10.	10	3·75—18·01

Results with 15 *c.c.* N/5 $HC_2H_3O_2$.

Following are the mean result of 120 titrations.

Percentage Present.

Fifteen c.c. of fifth normal acetic acid represent a weight of pure acid of 0·18 grm. In 135 grms. of material this represents 0·133 per cent.

The mean percentages of total acid present coming over with each successive 10 c.c. of distillate were as follows:—

1.	10 c.c. of distillate		1·02 per cent
2.	10	„	1·19— 2·21
3.	10	„	1·28— 3·49
4.	10	„	1·42— 4·91
5.	10	„	1·63— 6·54
6.	10	„	1·97— 8·51
7.	10	„	2·32—10·83
8.	10	„	2·76—13·59
9.	10	„	3·44—17·03
10.	10	„	4·55—21·58

Results with 20 *c.c.* $HC_2H_3O_2$.

20 c.c. of fifth normal acetic acid have 0·24 grm. of water free acid.

In 135 grms. of material this amounts to 0·178 per cent.

In all 260 titrations were made.

Following are the mean results showing percentage of total acid present, coming over in each successive 10 c.c. of distillate.

1.	10 c.c.		1·30 per cent
2.	10		1·56— 2·86
3.	10		1·78— 4·64
4.	10		1·88— 6·52
5.	10		2·15— 8·67
6.	10		2·50—11·17
7.	10		2·90—14·07
8.	10		3·48—17·55
9.	10		4·23—21·78
10.	10		5·58—27·26

* *Ann. d. Chim. et Phys.* (5), xi., p. 233 *et seq.*

† "Com. Organic Analysis," 2nd edition, i., p. 408 *et seq.*

Results with 30 *c.c.* $HC_2H_3O_2$.

30 c.c. N/5 $HC_2H_3O_2$ contain 0·36 grm. anhydrous acid. In 135 grms. of material this is 0·267 per cent.

The percentage of acid coming over with each successive 10 c.c. distillate was as follows (mean of 120 determinations):—

1.	10 c.c.	1·80 per cent
2.	10	1·92— 3·72
3.	10	2·00— 5·72
4.	10	2·13— 7·85
5.	10	2·40—10·25
6.	10	2·75—13·00
7.	10	3·03—16·03
8.	10	3·92—19·75
9.	10	4·80—23·95
10.	10	6·13—30·08

It was reasonable to suppose that an organic acid like lactic acid would itself be carried over mechanically to a certain extent in the process of distillation. Since pure acetic acid boils first when the temperature reaches 119°, all that comes over of it also must be carried mechanically in the other vapours or as a definite hydrate of low boiling point. To determine how much of the lactic acid would thus pass over, a large number of trials were made. 20 c.c. N/5 lactic acid in a total weight of 135 grms. were used in these determinations. The amount that came over in each successive portion of 10 c.c. of distillate was almost constant, and did not rapidly increase toward the last, as is always the case with acetic acid. The mean for each 10 c.c. was 0·0064 c.c. of the acid employed, or 0·0016 per cent. For the whole distillate of 100 c.c. this would give 0·016 per cent of the acid present. The percentage of lactic acid in the mixture distilled was 0·27. It is fair to presume that with a larger quantity of lactic acid the amount carried over mechanically must be somewhat greater.

In any case, however, with small percentage of lactic acid, the disturbing effect of the quantity going over can be approximately determined, and in no case is it very great.

It appears therefore that in a total acidity (in kumys or sour milk) of from 0·50 to 1·00 per cent due to the two acids, viz., lactic and acetic, it is possible to determine each of them with a satisfactory degree of accuracy, when the quantity of acetic acid present does not rise above 0·3 or fall below 0·1 per cent. If it should be less than 0·1 per cent the quantities distilled become so minute that the results are not reliable.

It would be interesting to continue the investigations with larger quantities of both acids, but since they do not usually occur in kumys or sour milk in greater amounts, the operations should be conducted in a liquid of a less complex nature than milk.

Separation of the Two Acids in Artificial Mixtures.

To test the accuracy of the determinations I had my assistant, Mr. Dugan, prepare for me various mixtures of milk and the two acids in proportions unknown to me. In most instances I was able to determine with gratifying accuracy the quantities used. In a few cases, however, the results were not accurate, but these were chiefly due to the use of a smaller quantity of the acids than indicated in the limits stated above, for the accuracy of the method.

Following are some of the results of the separation. The quantities of acid employed, as well as of those found by analysis, are given in cubic centimetres of fifth normal acid:—

Trial No. 1.

Found..	..	10·6 c.c. acetic acid.
Given ..	..	10·0 „ „
Found..	..	00·0 „ lactic acid.
Given ..	..	2·5 „ „

Trial No. 2.

Found..	..	0·92 c.c. acetic acid.
Given ..	..	1·00 „ „
Found..	..	8·78 „ lactic acid.
Given ..	..	9·00 „ „

Trial No. 3.

Found..	..	0·67 c.c. acetic acid.
Given ..	..	0·50 „ „
Found..	..	8·42 „ lactic acid.
Given ..	..	9·50 „ „

Trial No. 4.

Found..	..	2·94 c.c. acetic acid.
Given ..	..	3·50 „ „
Found..	..	6·29 „ lactic acid.
Given ..	..	6·50 „ „

Retention of a Portion of the Acid by the Precipitated Casein.

As I have already mentioned, I find that the best method of clarifying the milk for determining total acid present is by mixing it with an equal volume of strong alcohol. I found, however, using known quantities of acid in the milk, in titrating the filtrate, that the total acidity was not indicated. Here are some of the numbers obtained—in parts of acid known to have been added to the milk:—

1.	94·40 per cent	(lactic and acetic).
2.	98·04 „	„ „
3.	86·67 „	(lactic acid alone).
4.	96·20 „	(acetic „ „

It would appear from the above numbers that lactic acid is held back with more tenacity than acetic. As will be seen, the error which may occur from the above cause is likely to be greater than that arising from the distillation.

The exact cause of the error, its extent, and its remedy are subjects for future study.

As a result of the work the following method of procedure may be recommended:—

1. The sample of sour milk is mixed with an equal volume of alcohol, the acid determined in the filtrate with N/5 NaOH, using phenolphthalein as indicator. The quantity found to be taken at 95 per cent of the amount present.

2. 100 c.c. of the sour milk are diluted to 130 c.c. with water and a distillate of 100 c.c. taken off. The acetic acid in this distillate is estimated (using N/50 or N/100 alkali if necessary).

If less than 12 c.c. N/100 NaOH are required to neutralise the acid in the distillate, it can be assumed that not more than 10 per cent of the acetic acid present has been distilled over. From the total acidity, however, must first be deducted that due to the lactic acid carried over mechanically. If 0·3 per cent lactic acid be present it will be proper to deduct 6 c.c. N/100 from the total used. If 40 c.c. N/100 be required under the conditions above noted, then 18 per cent of the acetic acid may be considered to have come over. If 70 c.c. N/100 NaOH be required the acid distilled over should be estimated at 23 per cent.

If 110 N/100 NaOH be required, place the amount of acid distilled over at 27 per cent.

If the distillate require 200 c.c. N/100 NaOH the quantity of acid distilled over can be taken at 31 per cent.

For quantities intermediate among those given allow for proportionate percentages in the distillate.

Frothing of the Sample during Distillation.

Whether the object of distillation be the estimation of acid or alcohol, the difficulty of preventing frothing of the sample is great. I found that an ordinary test-tube brush, placed in the neck of the flask, was a most excellent

safety plug. The handle of the brush should be cut off so as not to interfere with the stopper. A thread tied to the stump of the handle and left hanging outside does not interfere with the stopper and is convenient for withdrawing the brush. The brush should be at first pushed into the flask, and then, by means of the thread, pulled up into the throat. The bristles then all point downward in a convenient position to puncture the bubbles. For alcohol distillations nothing better than this need be used. In the case of acids, however, there may be some danger of the metal of the brush being attacked, and some other device must be used. I found a small fine sponge pulled into the throat of the flask by a thread very efficient means of arresting the bubbles. Another excellent device is the use of a plug of fine asbestos fibre or of glass-wool. In all these cases the amount of liquid which the plugs will absorb must be approximately known, and this additional quantity of water added to the contents of the flask. I also employed a small platinum cylinder punctured with fine holes, which was attached by a rubber stopper to the delivery tube. The simplest device of all is to use a flask with a side delivery tube. The neck of the flask should be largest at the top and have a small constriction just as it enters the bulb. A perforated platinum cone large enough to fill the neck is placed point down in it. The constriction prevents it from entering the bulb. In this way the bubbles are prevented from entering the delivery tube, and no correction is to be made for absorbed liquids.

CORRESPONDENCE.

RADICAL OR RADICLE?

To the Editor of the Chemical News.

SIR,—Some eighteen years ago, I think, after the word *radical* had long been in use by English chemists, equally with their continental brethren, there was put forth the view that this word was incorrect, and should be replaced by *radicle*. Miller adopted the new word in his last edition of his "Elements of Organic Chemistry" (1869), and the Publication Committee of the Chemical Society has since enforced its use in the *Journal*. The old term has never been seriously defended against the attack then made upon it, yet it is still largely used by eminent chemists in their publications. Recently Mr. Madan, in *Nature*, has attacked the use of *radical* as being incorrect grammatically, and has been replied to in the same journal by Mr. Heyes, who defends the use of *radical* for historical reasons, but apparently admits that *radicle* is the right word, and would have both in use. Here, to me at this date, the matter seems likely to rest, and this I should be sorry to see it do, for I hold not only that *radical* is right, but that *radicle* is wrong—an opinion in which I think there will be many to agree with me.

The word *radical*, we have been told all along by its objectors, is not a *noun*, but an *adjective*, and we are apparently referred to the German for the original use of it in chemistry (Miller, *l. c.*). But the term is much more foreign to German than to English, and both languages owe it, of course, to early French. Besides in German, as in English and French, it is primarily an *adjective*; and why in English it should not be used *substantively* in chemistry, equally as it is in French and German, is to me incomprehensible. Together with the adjective *liberal* it is used in politics as a noun, but, for some obscure reason not necessary to fathom, this use of it is held by its opponents in chemistry not to have sufficient analogy. Its use as a noun is clearly in accordance with the genius of our language, for we say *animals, menials, officials, principals, cardinals, fundamentals*, and in Science *proportionals, differentials, exponentials, integrals, chemicals*; why then not *radicals* also? From its earliest use, in French or English, it has meant *pertaining to the essence or principle of things*, and the chemist now uses it for something that he regards as one of the *bases* or *elements* of a substance. *Simple radical* is to him synonymous with *element*, and probably but for the inconsistency of the term *compound element* the word *radical* would not have gained the standing it now has in chemistry. Thus much as to the rightness of the word *radical*.

The word *radicle* is improperly used in chemistry, and should have no place there. It is the *diminutive* of *radix*, and never enjoyed a figurative use until introduced into chemistry. It has always meant *rootlet*, and is still used fully and exclusively in that sense by botanists and anatomists. Those chemists, therefore, who will have *radicle* in place of *radical* can only justify their action by affirming that they regard compound and simple radicals as the *rootlets* of substances. Such a conception is not a happy one, and certainly it is not a true one. Radicals are of the *essence* or *basis*; they are the *elements*, or figuratively the *roots*, of substances. They are all in all to the substance, not some diminutive parts of it. Both Mr. Madan and Mr. Heyes make play upon the words *particle* and *partical*, as though the latter would be analogous to *radical*; but diminutives in *-cle* do not form adjectives in *-cal*, and *radical* gets its *-c-* from *radix* or *radicem*. To use *radicle* for *radical* seems to me as big a blunder as to use *principle* for *principal*, a chief.—I am, &c.,

EDWARD DIVERS.

Tokyo, Japan, June 2, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. cii., No. 26, June 28, 1886.

Researches on Ramie.—E. Fremy.—The substances which cement together the fibres and the cellules of this plant are pectose, cutose, and vasculose, all of which can be removed by means of suitable reagents.

Fluorescence Formerly Attributed to Yttria.—Lecoq de Boisbaudran.—(See p. 15).

Action of an Electric Current upon Hydrofluoric Anhydride.—H. Moissan.—On submitting to electrolysis by means of a current of 50 Bunsen elements in a platinum U-tube hydrofluoric acid prepared by M. Frémy's process, and with all the precautions indicated by him, we obtain, on operating at −50°, at the negative pole an escape of hydrogen easily recognised; at the positive pole a continuous current of a gas presenting the following properties:—In presence of mercury it is completely absorbed, with formation of mercury fluoride of a light yellow colour; it decomposes water, giving off ozone; phosphorus is ignited by this gas, yielding phosphorus fluorides; sulphur is heated and melts rapidly; carbon seems to be without action; melted potassium chloride is attacked in the cold with an escape of chlorine; crystalline silicon, washed with nitric and hydrofluoric acids, takes fire in contact with this gas and burns brilliantly, forming silicon fluoride. The electrode of platin-iridium forming the positive pole is strongly corroded, whilst that of the negative pole is untouched. The most simple explanation of these phenomena is that we are here in presence of fluorine, but it may possibly be a hydrogen perfluoride, or even a mixture of hydrofluoric acid and of ozone active enough to explain the energetic action of this gas upon crystalline silicon.

Spectra of Didymium and Samarium.—Eug. Demarçay.—On examining photographically the ab-

sorption spectra of various products of the fractionation of didymium and samarium the author has obtained some novel results. The fractionations have been partly effected by the method of crystallising the double ammonium nitrates as proposed by Herr Auer von Welsbach, partly by fractionated precipitation with dilute ammonia, but chiefly by a third method. It is known that the spectrum of samarium contains in its violet and ultra-violet portion bands described first by M. de Boisbaudran (*Comptes Rendus*, lxxxix., p. 212) and then by M. Soret (*Archives des Sciences Physiques*, iv., p. 65). Their wave-lengths are:—419—415, 407, 400, 374. The author has observed that the bands 417 and 374 may be very distinctly separated from the band 407 and the band 400, which seem to accompany each other as do the two former bands. Hence samarium, as defined by these four bands, contains in reality at least two simple bodies. If the name samarium is retained for one of them, defined by the bands 407 and 400, the other may be provisionally designated by S_γ. Didymium has been split up by Auer von Welsbach into several bodies:—praseodymium, neodymium, and a third body of which this skilful chemist says nothing, though he has implicitly admitted its existence by eliminating from the spectra of neodymium and praseodymium one of the rays ($\lambda = 476$) of didymium. There is also in didymium a ray ($\lambda = 462$) of which Herr von Welsbach does not speak, and which he does not introduce into his figures, though it is well known. This ray appears to belong to the same body as the ray 471, as they are always found to vary in the same manner. In the spectrum of several fractions there is also a very narrow ray not yet described ($\lambda = 434$ about) which belongs neither to praseodymium nor neodymium. Whether it belongs to the third body ($\lambda = 476$) could not yet be decided. It seems, however, to vary in a rather different manner.

New Double Copper and Ammonium Iodide.—A. Saglier.—This compound is obtained by the direct action of iodine dissolved in alcohol upon the ammoniacal solutions of copper oxide. Its composition is $2NH_3,Cu_3I_2$.

Synthesis of an Inactive Terpilenol.—MM. Bouchardat and Lafont.—This compound, obtained by the very prolonged action of glacial acetic acid upon caoutchine is a neutral liquid of a pale amber colour and an aromatic odour. It boils at 110° to 115° in a vacuum and at 220° at the ordinary pressure, but in this case with partial decomposition.

Action of Anhydrous Baryta upon Methylic Alcohol.—M. de Forcrand.—The author has obtained a barium compound, soluble in water and in methylic alcohol.

Decompositions of Pilocarpine.—MM. Hardy and Calmels.—Pilocarpine may be split up by boiling its aqueous solution and by oxidation by means of potassium permanganate.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 2, 1886.

Separation of Copper from Cadmium.—A. Béhal.—From *Journal de Pharmacie et de Chimie* and already noticed.

Some Characteristic Reactions of the Salts of Gold.—Ad. Carnot.—Noticed under *Comptes Rendus*.

New Method for Determining Chromic Acid in Chromates and Bichromates.—J. W. Chalmers Harvey. From the Chemical News.

Determination of Silicon in Iron.—L. Blum.

A New Volumetric Method for Determining Nitrous Acid.—A. G. Green and S. Rideal.—From the Chemical News.

Qualitative Detection of Nitric Acid.—A. Arnaud and L. Padé.—From the *Comptes Rendus*.

Determination of Nitrogen Present as Nitric Acid. J. Boyd Kinnear.—From the Chemical News.

Method of Obtaining Spark-spectra with Liquids.—E. Demarçay.—Already noticed under *Comptes Rendus*.

Detection of Traces of Nitric Acid.—Curtman (*Pharm. Rundschau* and *Chemiker Zeitung*).—Nitric acid yields with pyrogallic acid a deep brown mass of so great tinctorial power that by means of this reagent smaller quantities of nitric acid can be detected than with di-phenylamine. In this manner one-tenth of a milligramme of nitric acid can be distinguished in a litre of water. The water to be examined is mixed with less than 1 m.grm. pyrogallic acid per c.c. and 10 to 12 drops of strong sulphuric acid are cautiously let flow into the test-tube, so that two layers are formed. If nitric acid is present the zone of contact turns brown, or, in case of smaller quantities, yellow. P. T. Austen and J. C. Chamberlain (*Amer. Chem. Journal*) recommend, instead of copperas, ferrous-ammonium sulphate for the detection of nitric acid, as it can be kept in solution.

Germanium, a New Non-Metallic Element.—C. Winkler.—Already noticed.

Absorption-Spectra of Various Colouring Matters. Ch. Girard and Pabst.—From the *Comptes Rendus*.

Phenylhydrazine as a Reagent for Aldehydes and Ketones.—E. Fischer.—(*Ber. Deutsch. Chem. Geselsch*).

Compounds of Phenylhydrazine with the Sugars.—C. Fischer.—(*Berichte Deutsch. Chem. Gesellsch*). These two memoirs do not admit of useful abstraction.

The Non-Identity of Arabinose and Lactose.—This subject has been discussed in various journals by Claesson, Kiliani, O'Sullivan, Scheibler, Fischer, and O. von Lippmann.

On Milk-sugar and Galactose.—W. H. Kent and B. Tollens.—From *Tiebig's Annalen*.

On Perseite.—A. Muntz and V. Marcano.—This paper, from the *Annales de Chimie*, is merely mentioned.

Raffinose and Melitose.—This sugar, occurring in beet-treacle and cotton seed, has been the subject of a series of memoirs by Tollens, von Lippmann, Scheibler, Reschbiet, Rithausen, and Böhn.

Nomenclature of the Sugars.—C. Scheibler.—The author proposes that the termination "ose" shall be confined to sugars of the formula $C_6H_{12}O_6$, whilst those of the formula $C_{12}H_{22}O_{11}$ shall terminate in "biose."

Circular Polarisation of Dextrose.—B. Tollens.—The rotatory power decreases with decreasing concentration.

Optical Rotatory Power of Inverted Sugar.—O. Gubbe.—The author examines the influence of the acid used in inversion, the concentration, and the temperature.

The Absorption-Spectra of Alkaloids.—W. N. Hartley.—From the Chemical News.

Behaviour of some Alkaloids with Bromine-Water.—C. L. Bloxam.—From the Chemical News. The same subject has been further examined by Arnold Eiloart in the same journal.

Characteristic Reactions of Codeine and Æsculine.—L. Raby.—From the *Journal de Pharmacie* and the *Chemiker Zeitung*.

On Officinal Veratrine.—E. Bosetti.—This body is a mixture of two isomeric alkaloids, veratrine (cevadine) and veratridine, the former insoluble in water, the latter soluble.

On Cantharidine.—E. Dietrich.—This compound is characterised by the phenomenon which it displays in the solid state in polarised light, especially when a drop of the solution in chloroform is allowed to evaporate and the residue is examined with the polarising microscrope. Its solutions have no effect upon polarised light.

On Kjeldahl's Method for Determining Nitrogen.—G. Czeczetka.—Instead of solid permanganate in powder the author uses a saturated solution of this salt in

sulphuric acid, and allows it to flow slowly down into the liquid through a long-necked funnel. He recommends phenolphthaleine instead of litmus.

On Pikrotoxine.—E. Schmidt.—From *Liebig's Annalen*.

Determination of Tannin on Lowenthal's Method.—R. Ulbricht.—The author declares his approval of Schroeder's c.c. method. For a standardising substance he rec ommends potassium quadroxalate, the solution of which, in a sterilised condition, keeps for 14 days. He sterilises also the solution of indigo.

Agreements on the Examination of Articles of Food, &c.—A. Hilger.—The author has published the procedures selected by the Bavarian chemists.

The Fermentive-Power-Tester.—E. Kœlitz.—This instrument, being patented, can be here merely mentioned.

Action of Organic Acids upon Lead and Tin.—F. P. Hall.—From the CHEMICAL NEWS.

Analysis of Copper.—John Pattinson.—From the CHEMICAL NEWS.

Determination of Oxygen in Copper.—O. Pufahl.—(*Berg. u. Hütten Zeitung*).—The author uses 10—20 grms. of bright turnings, not more than 1 m.m. in thickness, carefully removing grease with anhydrous ether. They are weighed in a porcelain boat, and heated for about an hour in a current of pure hydrogen at about 500°. The oxygen is calculated from the loss of weight.

Analysis of Iron.—H. von Jüptner.—(*Chemiker Zeitung*).—Good results are obtained by Drown and Shimer's method for the determination of silica, only if the nitric acid is entirely expelled.

Analysis of Iron and Steel.—F. Watts.—From the CHEMICAL NEWS.

Colorimetric Determination of Carbon in Iron and Steel.—A. E. Hunt.—The author's method is not described.

Determination of Carbon in Iron and Steel.—Sarnstrom.—(*Berg u. Hütten Zeitung*).—The author burns the hydrocarbons, collects the carbonic acid formed in a potash-apparatus, and from its weight determines the carbon volatilised in the form of hydrocarbons.

Determination of Sulphur in Iron and Steel.—G. Craig and H. Rocholl.—From the CHEMICAL NEWS.

The Sulphur in Iron Ores.—V. Eggertz.—(*Berg. u. Hütten Zeitung*). The author points out that barium sulphate, present in many ores, is often overlooked in analyses.

Determination of Phosphorus in Irons.—A. Tamm.—From the *Berg. u. Hütten Zeitung* and the CHEMICAL NEWS.

Distinction between Iron and Steel.—D. Sevoz.—(*Jour. Pharm. et Chimie*). Already noticed.

Detection of Slight Gilding and Silvering.—For this paper we must refer to the original.

Specific Gravity of Milk of Lime.—Blattner and G. Lunge.—The author pours the liquid into a hydrometer-glass, inserts the hydrometer and sets the glass in rotation, reading off when the hydrometer ceases sinking.

The Determination of Effective Chlorine in Chloride of Lime.—J. W. Chalmers Harvey.—From the CHEMICAL NEWS.

Testing Petroleum.—Sir F. Abel and Boverton Redwood.—From the CHEMICAL NEWS.

Determination of Free Acid in Tan-Liquors.—B. Kohnstein and F. Simand.—The authors determine volatile organic acids, fixed organic acids, and sulphuric acid.

Detection of Pure Indigo Dye.—Phillips.—(*Chemiker Zeitung*).—The author strips the swatch with warm dilute nitric acid (1 : 6). Cloth dyed with pure indigo takes a straw colour; that grounded with logwood or sanders takes a more brownish shade.

Testing Saffron-Substitute.—G. Heppe.—This memoir is merely mentioned.

Examination of Vulcanised Caoutchouc.—C. Reinhard.—If incinerated in a muffle the ash is lower than if ignited over a lamp, keeping the temperature so low that the crucible does not become red. The editor cautions against the use of platinum crucibles, as the sample may contain antimony.

Examination of Cinchona Barks.—Squibb.—From the CHEMICAL NEWS.

MISCELLANEOUS.

British Association, Birmingham Meeting, Section B.—It has been arranged that a discussion shall be held at the Birmingham meeting of the British Association, on the Nature of Solution. The discussion will be opened, in Section B, on Friday, Sept. 3rd, by Professor Tildes, F.R.S., and Professor Armstrong, Dr. Gladstone, Professor Guthrie, Professor Hartley, and Dr. W. W. J. Nicol, are expected to take part in it. Gentlemen who are willing to contribute papers on this subject, or to take part in the discussion, are requested to communicate with the president of Section B, Mr. Crookes, F.R.S., at the office of this paper, not later than August 1st.

Celebration of the Centenary of M. Chevreul.—On August 31st M. Chevreul, the *doyen* of the scientists of the entire world, reaches the hundredth year of his life. A subscription has been opened to commemorate this event by a medal, to be executed by M. Roty, and a committee has been formed, under the presidency of M. C. Brongniart. All persons who wish to take part in this tribute of recognition to the illustrious and venerable *savant* may forward their subscriptions to M. Brongniart or to M. Louis Passy, at the offices of the Société d'Agriculture, 18, Rue de Bellechasse, Paris.

MANCHESTER CORPORATION GAS WORKS.

TAR.

THE Gas Committee of the Corporation of Manchester are prepared to receive Tenders for the Purchase and Removal of the Tar in stock, and to be produced at their Gaythorn Gas Works during a period of one or more years, commencing from the 1st day of August, 1886. The Committee do not bind themselves to accept the highest or any Tender. Sealed tenders, addressed to the Chairman of the Gas Committee, and endorsed, "Tender for Tar," must be delivered at the Offices of the Gas Department, Town Hall, on or before Wednesday, the 21st of July, 1886.

Forms of Tender and further particulars may be obtained on application in writing to Mr. Charles Nickson, Superintendent of the Department.—By order of the Gas Committee,

JOS. HERON, Town Clerk, Manchester.

Town Hall, 1st July, 1886.

ST. PAUL'S SCHOOL.—An Examination for filling up about 25 Vancancies on the Foundation will be held on the 9th September next.—For information apply to the Bursar, St. Paul's School, West Kensington.

ENAMELLING.

Wanted the address of a Firm or Chemist who will undertake the enamelling of hard soldered German Silver, to stand the action of hot potash and cyanide.—Address for Samples, "Enamel," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

TO MANUFACTURING CHEMISTS.

TO BE LET, a Modern well-built Works, advantageously situated in the immediate neighbourhood of Manchester. Would be adapted to suit any branch, or divided to suit a Tenant at a low rental.—Address, A. B., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

THE CHEMICAL NEWS.

Vol. LIV. No. 1391.

WHAT IS YTTRIA?

By WILLIAM CROOKES, F.R.S.

A discussion has been going on for some time before the Académie des Sciences between M. Lecoq de Boisbaudran and myself which is likely to turn upon a point in etymology rather than in chemistry.

No longer than twelve months ago the name yttria conveyed a perfectly definite meaning to all chemists. It meant the oxide of the elementary body yttrium. I have in my possession specimens of yttria from M. de Marignac (considered by him to be purer than any chemist had hitherto obtained), from M. Clève (called by him "purissimum"), from M. de Boisbaudran (a sample of which is described by this eminent chemist as "scarcely soiled by traces of other earths"), and also many specimens prepared by myself at different times and purified up to the highest degree known at the time of preparation. Practically these earths are all the same thing, and up to a year ago every living chemist would have described them as identical, *i.e.*, as the oxide of the element yttrium. They are almost indistinguishable one from the other both physically and chemically, and they give my phosphorescent spectra *in vacuo* with such extraordinary brilliancy that it would be absurd to say that the phosphorescence was due to "feeble traces" of impurities.

This is what I formerly called yttria, and have more recently called *old* yttria.

In a subject so obscure as this is it cannot be expected that an ardent worker in his laboratory should always retain perfect consistency in his choice of words; but I must point out, in the use of the word "yttria" as employed by M. de Boisbaudran, a certain ambiguity which is very confusing.

I have never varied in my meaning. By "yttria" I mean now, and always have meant, the yttria of Clève, of Marignac, and of all chemists up to the beginning of this year. I confess, however, I cannot quite make out what precise meaning M. de Boisbaudran attaches to the word yttria. At one time it would seem as if our meanings were identical. Thus, he writes: "It is certain that my earth, very rich in yttria, gives a beautiful spectrum in the vacuum tube." Again, he informs me,—"M. Becquerel has recently examined my earths A and B in ultra-violet light, and has obtained results analogous to yours; that is to say, the earth rich in yttria has generally shone brighter than the other." The earth A, here spoken of, gives my phosphorescent spectrum with wonderful brilliancy, and is the one described above by M. de Boisbaudran as "yttria scarcely soiled by traces of other earths." This yttria, my learned friend goes on to say, is "the same as that of Clève and Marignac, only varying in trifling impurities, Marignac's being perhaps the purest." So far we are agreed in the meaning to be attached to the word yttria.

But M. de Boisbaudran at another time gives the name yttria to an earth of very different properties—to an earth which he has only obtained in most minute quantities after months of unremitting work, to an earth which gives no phosphorescent spectrum in the vacuum tube,—to an earth in fact so difficult to prepare that M. de Boisbaudran himself has not yet succeeded in getting any which really possesses this property. This kind of yttria, therefore, only exists in theory.

What evidence is there that this scanty modicum of ideal earth giving no phosphorescence is really pure yttria? and why may we not call any of the other phosphorescing earths which M. de Boisbaudran says are impurities, yttria? To refine away the most striking characteristics of a body, to call the *caput mortuum* by the original name, and then dub all the rest *impurities* is an inversion of scientific reasoning which must not be allowed to pass without protest.

It is known to the readers of this Journal that the earth hitherto called yttria is a highly complex molecule, capable with an enormous expenditure of time and material, of being split up into several simpler bodies. Now these constituents of old yttria are not *impurities* in yttria, any more than praseodymium and neodymium (assuming them really to be elementary) would be impurities in didymium. They constitute a veritable splitting-up of the yttrium molecule into its constituents, and when this is done there is nothing left of what used to be called yttria. This being the case I, by right of first discoverer and the general custom obtaining among men of science, am allowed to give these elements any name I like. As, however, some of them might not be new, and it would retard chemical science and bring research into disrepute if new elements were to be rashly thrown into the world with no more justification for their existence than a line in a spectrum, I did not give names to these probationers, but contented myself for the present with calling them Gα, Gβ, Gγ, Gδ, Gε, Gζ, Gη.

If these really turn out to be new elements, and I decide to call one of them yttrium, I am not exceeding my right to do so; and if I decide that it would introduce confusion to give the same name to a constituent which is already appropriated for the very stable compound molecule in which it occurs, I shall be perfectly within my rights if I give new names to each of the constituents of yttrium. One of the characteristics of what I must call for clearness old yttrium is a well-defined spark spectrum. I have not yet separated the constituents with sufficient accuracy to be able to say which of them gives this spark spectrum. It may be that the particular element to which this is due gives no phosphorescent spectrum; on the other hand the spark spectrum may turn out to be as compound as the original earth, and the well-known lines in it will have to be apportioned between two or more of the new bodies. I wish, however, to emphasise the statements that at present no one constituent of old yttria has any more claim to the paternal name than has any other constituent; that if I like to retain the name yttria for the compound parent molecule and give distinct names to each constituent I may do so; and especially that no one has any right in the present state of the question to call one of the new bodies yttria and to speak of all the others as impurities.

It is well known that M. de Boisbaudran has been working for some time on a new method of spectrum analysis, obtaining *reversion* spectra, by which he has discovered what he considers to be two new earths, Zα, Zβ. The details of his method are given in the Chemical News (vol. lii., p. 4), so I need not repeat them. In the hands of a practised experimentalist like M. de Boisbaudran this method may give trustworthy indications, but I must confess that in my opinion the test is one beyond the range of practical analysis, owing to the enormous difficulty of getting the phenomena described by the discoverer. Unless the strength of spark, the concentration and acidity of solution, and the dispersion and magnifying power of the spectroscope bear a certain ratio one to the other, the observer is likely to fail in seeing a spectrum even in solutions of earths which contain considerable quantities of Zα and Zβ. In my own case I not only have had the advantage of personal instruction in Paris from M. de Boisbaudran himself in the best method of getting these reversion spectra, but on returning to London I brought with me some of the identical earths which give these spectra at their best. In spite of these advantages I have sometimes experimented off and on for weeks without being able to see more than a feeble glimmer of the bands described by M. de Boisbaudran.

Again, when everything is most favourable and the reversion bands are at their strongest, they are but a faint and hazy shadow of the brilliant lines given by the bombardment process. M. de Boisbaudran, speaking of the relative sensitiveness of our two methods, says that the bombardment process *in vacuo* is incomparably more delicate than his reversion test, and I estimate the relative sensitiveness of the two methods to be in the proportion of about 1 to 100.

On reference to my paper in last week's CHEMICAL NEWS (p. 15), it will be seen that I said the earth giving the close pair of greenish blue bands (mean λ 545) was probably gadolinium or $Z\beta$; and on p. 14 I explain this by saying that "gadolinium is composed of at least four simpler bodies," $G\beta$, $G\gamma$, $S\delta$, and $G\zeta$, "the pair of green lines (λ 541 and λ 594, mean 545), being the strongest feature in its spectrum, may be taken as characteristic of gadolinium." In his paper in the same number of the CHEMICAL NEWS M. de Boisbaudran says: "Mr. Crookes appears to attribute to gadolinium the double green band." This is scarcely accurate; I did not ascribe the double green band to gadolinium, but, finding by my test that the so-called gadolinium was a compound body, the earth $G\beta$ being the strongest component, I proposed to attach the name of gadolinium to $G\beta$, rather than give it a new name and so multiply names unnecessarily.

These double green bands are also claimed by M. de Boisbaudran as characteristic of $Z\beta$, and he now admits that his $Z\beta$ is terbia. We have therefore four claimants for the double green bands — $G\beta$, gadolinia, $Z\beta$, and terbia. Until therefore it has been proved that the phosphorescence of the anhydrous sulphates *in vacuo*, and the feeble fluorescence of the hydrochloric solutions by reversion, are caused by the same bodies, I had better adhere to my original suggestion, and speak of the earth as $G\beta$, 545.

I wish to make one thing very clear. I stated before the Royal Society that $G\delta$ was probably M. de Boisbaudran's $Z\alpha$, and that $G\beta$ was probably his $Z\beta$. I do not think my friend has yet proved their identity, but, on the other hand, I cannot say that I am at all certain as to their non-identity. The matter is in a fair way to be settled one way or the other, if my eminent opponent on one side and I myself on the other, each working almost night and day, can settle it. I must, however, state emphatically that I have not the slightest wish to include $Z\alpha$ and $Z\beta$ amongst my new elements. All along I have studiously tried to avoid anything that should seem to favour such a view.

Experimental research is necessarily and slowly progressive, and early provisional hypotheses have to be modified, adjusted, perhaps altogether abandoned, in deference to later observations. We do not censure the dawn for not being full daylight, nor should an experimenter's more advanced researches be used to condemn and discredit his first gropings after truth. We are both working for the truth whithersoever it leads, and, so long as we succeed in finding the truth, I am sure both my learned friend and myself will be content to preserve a philosophic equanimity whether $G\delta$ is really a new earth, whether it is $Z\alpha$, whether $G\beta$ is identical with $Z\beta$, or whether $Z\beta$ proves to be, as M. de Boisbaudran now thinks, terbia.

On the Non-metallic Fluorides.—M. Guntz.—The author has been led by thermo-chemical considerations to think that lead fluoride ought to be decomposed by all the non-metallic chlorides. He, therefore, treated lead fluoride with carbon chloride, sulphur sub-chloride, phosphorus trichloride and oxychloride, obtaining in each case a lead chloride and a fluorine compound. In the case of phosphorus terchloride and oxychloride the gases obtained possess the properties mentioned by M. Moissan.—*Comptes Rendus*, vol. ciii., No. 1.

ON RADIANT MATTER SPECTROSCOPY.*

PART II.—SAMARIUM.

By WILLIAM CROOKES, F.R.S.

(Continued from p. 31).

Is "x" a Mixture?

109. FOR a considerable time strontium minerals and salts only were worked upon, these being considered the cheapest and most fruitful sources of *x*. A considerable quantity of material was thus accumulated, showing the desired spectrum with great brilliancy. When, however, attempts were made to separate the spectrum-forming body from the accompanying elements, as strontium. calcium, &c., all the foregoing anomalies were displayed. Ultimately two portions of substance were produced—a precipitate (113) containing the supposed new element, and a filtrate, containing the strontium, calcium, and other impurities. Neither the precipitate nor filtrate tested in the usual manner showed the orange band anything like so well as the material before such separation, and indeed at this stage of the experiments it frequently vanished altogether.

Some of the filtrate and precipitate were now mixed together, treated with sulphuric acid, and tested as before: they gave the orange-band spectrum as brightly as did the original substance. The ammonia precipitate was too small for analysis, but judging from its origin it might contain any or all of the rare earths. Chemical analysis showed nothing but a calcium salt in the filtrate.

110. Could it be that the union of two bodies was necessary to give this spectrum, and that calcium was one of these? Could the other constituent be of the nature of an acid such as boric, or a halogen like fluorine?

Many experiments were tried to test this hypothesis. Pure Iceland spar was dissolved in acid, a little of the above described precipitate added, and the mixture tested in the usual way. The orange band appeared again.

Every conceivable mixture was now made of lime with other bodies, but whilst I frequently obtained faint indications of orange band there was never sufficient to satisfy me that I had artificially formed the spectrum-bearing body; the traces observed were evidently due to the all-pervading presence of the sought-for body.

So far all had been contradictory and disheartening. Analogy with the yttrium results failed to throw light to guide through the gloom. The hypothesis that the body sought was an earth, widely diffused in minute quantities only, and that its anhydrous sulphate gave a phosphorescent spectrum in the radiant-matter tube, had guided me a certain distance and then led me widely astray. A new factor must now be taken into account—the presence of a calcium compound appeared to be necessary. An earthy body which, when treated and tested in the usual manner, fails to show the faintest glow of an orange-band spectrum, can by admixture with calcic sulphate be made to yield a pure and brilliant spectrum, rivalling in clearness and beauty that given by yttric sulphate.

111. Of the two components of the phosphorescing body—calcium and *x*—which is the necessary and which is the variable factor?

This question did not appear difficult to answer. In the first case the calcium must be kept the constant, and *x* be made the variable quantity.

A piece of pure colourless Iceland spar—the sulphate from which had been proved to phosphoresce normally with a greenish blue light, without bands or concentration in any part of the spectrum (164)—was dissolved in hydrochloric acid, and mixed with about 10 per cent of various metallic sulphates. Sulphuric acid was added, the mixture evaporated to dryness, ignited, and tested in

* A Paper read before the Royal Society, June 18, 1885.

a radiant-matter tube. The bodies thus used to replace x, in addition to the more common earths, were the earths from samarskite—enumerated in the first part of this paper (40)—in as pure a state as I could get them, together with various earthy precipitates, oxalates, &c., obtained from different minerals during the preceding operations.

These experiments resulted in an *embarras de richesse*, Whereas, hitherto, I had considered the orange-band-forming body rare and sparsely distributed, I now found it sharing with yttrium the attribute of ubiquity. The answer to my question was too full, and left me again in doubt as to whether calcium or x was the variable quantity.

The yttrium spectrum turned up in this series of experiments about as frequently as the orange-band spectrum. I knew that in such cases yttrium was present as an impurity; might it not be that the almost universal occurrence of the orange-band spectrum was equally caused by a minute but varying quantity of x in the earths under test?

112. I took them one by one and submitted them to further severe chemical treatment, fractionally precipitating them, in cold dilute solution, with weak ammonia, or fractionally crystallising their oxalates from nitric acid. As the purification progressed the orange-band spectrum generally lessened in intensity till in the case of many earths it faded out altogether, and in most of them it gave evident indications of being extraneous to the earth itself. In some instances, however, the spectrum increased in intensity; moreover, when the purified earth showed any diminution of the orange band the eliminated impurity always showed the orange band in an exalted degree. I drew from these experiments the inference that x was a definite element, as widely distributed, or nearly so, as yttrium, but requiring admixture with a calcium compound to bring out its phosphorescent properties.

113. Next I had to ascertain if the calcium could be replaced by any analogous body. In this case, therefore, the x was kept constant whilst the calcium was replaced. An ammonia precipitate (109) from a rich accumulation of orange-band substance was chosen as the x. Tested in the usual manner, by itself, it showed nothing, but mixed with lime it gave the orange-band spectrum very bright and pure.

The metals used to mix with it were in the form of sulphates—strontium, barium, glucinum, zirconium, thorium, magnesium, zinc, cadmium, lead, copper, silver, cerium, lanthanum, didymium, aluminium, manganese, tin, bismuth, antimony; also silicic, titanic, tantalic, tungstic, molybdic, and niobic acids. More than half of these bodies possessed the property of conferring "orange-band" phophorescence on the precipitate under examination, although by themselves they evinced no power of giving a phosphorescent spectrum.

Explanation of foregoing Anomalies.

114. In this manner the remarkable fact was established that the x I sought was an earth which of itself could give little or no phosphorescent spectrum in the radiant-matter tube, but became immediately endowed with this property by admixture with some other substance, which substance likewise by itself had no power of phosphorescing with a discontinuous spectrum.

Of the great number of bodies used to mix with the earth x in these experiments, which acted best? It was not easy to try comparative experiments at this early stage: ultimately I came to the conclusion that lime, if not the best, was as good as any.

115. These results afford a full explanation of the anomalies which had so long hampered my endeavours to repeat on a large scale experiments which, when working with small quantities, had given good results (99, 101, 108). The preliminary experiments were intended to ascertain whether the desired orange band was present or not. Natural impatience led to hurried operations and defective washing of precipitates, and thus some of the necessary *lime* was left with the phosphorescing body. The subsequent larger operations were performed in a more systematic manner with the object of securing as large a yield of substance as possible. The precipitates were thoroughly washed, the lime was more completely thrown out, and the sought-for earth, although obtained, refused to reveal itself by the spectroscope and radiant-matter tube.

The contradictory behaviour of the sulphate to water (99) was now easily explained. The insoluble crystals, which from the brilliancy of their phosphorescent spectrum I had at first mistaken for the nearly pure sulphate of x, were merely calcic or strontic sulphate contaminated with perhaps not more than the one ten-thousandth part of x sulphate which it had carried down with them on crystallising.

"X" in Cerite.

116. In the corresponding yttrium research I was aided materially by the fact that the sought-for earth did not give an absorption spectrum (42). This enabled me to throw out a large number of obscurely known elements, and I therefore early endeavoured to ascertain whether the supposed new earth, x, did or did not give an absorption spectrum. At first I could not decide one way or the other. I frequently obtained a good orange-band spectrum when the solutions gave no trace of absorption spectrum, whilst on other occasions the solution showed good didymium and other bands. Gradually, however, it was noticed that whenever the didymium absorption bands were strong the orange-band spectrum was also particularly brilliant. Moreover, amongst the earths enumerated in par. 113 as mixed with lime in the quest for x, I have mentioned that some of them gave the orange-band spectrum with increased intensity; the earths of the cerium group were the most noteworthy, and these considerations made it probable that here would be found the location of x.

117. On a former occasion, when searching for the citron-band-yielding earth, and examining cerite (22 to 25), I made use of the potassic-sulphate method of separating the two great sub-groups, viz., the cerium and the yttrium earths; the former giving insoluble, and the latter soluble, double sulphates. I said (23):—

"The precipitated double sulphates were dissolved in hydrochloric acid, and the earths precipitated as oxalates. After ignition and treatment with sulphuric acid, the mixed ceria, lanthana, and didymia were tested in the radiant-matter tube, but the merest trace only of citron band was visible."

A repetition of the above experiment produced similar results. The contents of the tube were now removed, mixed with lime and excess of sulphuric acid, ignited, and again tested in the tube. This time the orange-band spectrum came out very brilliantly, showing in a striking manner the necessity of supplementing x with some other earth to bring out its phosphorescing properties.

The cerium group, to which x was now almost certainly traced, consists of cerium, lanthanum, didymium, samarium, and perhaps yttrium-α (136). The other metals, enumerated in par. 101 as being precipitated by potassic sulphate, were found not to phosphoresce with a discontinuous spectrum, either alone or when mixed with lime.

Analysis of Cerite.

118. The first necessity was to get the earths ceria, lanthana, and the mixture hitherto called didymia, in a pure state, for my so-called pure earths of this group all showed the orange band in more or less degree.

About 14 lbs. of cerite were finely ground, made into a thick paste with strong sulphuric acid, and heated to drive off excess of acid. The mass became of a white or pale grey colour. This was digested in cold water, filtered, and the residue well washed with cold water.

To the filtrate oxalic acid was added, which precipi-

tated all the earths, with any lime, &c., that might be present as oxalates. It saves times at first only to aim at a partial separation of the mixed earths, and for this purpose it is well to proceed as follows:—The dried oxalates are boiled with strong nitric acid till completely decomposed, the nitrates are evaporated to dryness, mixed with three times their weight of nitre, and fused at the lowest temperature at which nitrous fumes come off; the residue is digested in water, filtered, and washed. The insoluble residue, of a pale yellow colour, consists of ceric oxide and basic ceric nitrate, with a little of the other oxides, whilst the filtrate contains the bulk of the lanthanum, didymium, and samarium.

Separation of Ceria, Lanthana, Didymia, and Samaria.

119. To free the lanthanic, didymic, and samaric nitrates from the last traces of cerium it is necessary to fuse them again very gently with three or four times their weight of potassic nitrate, at a temperature just sufficient to cause slight decomposition. The operation of fusing must be repeated on the evaporated filtrate many times to throw out all the cerium.

The ceric oxide, or basic nitrate obtained, is freed from any didymium by re-treatment with nitric acid and fusion as above; the presence of didymium being indicated by its brown colour or by the absorption spectrum of the solution.

120. The separation from each other of lanthana, didymia, and samaria is a most laborious process, and the amounts of these earths, obtainable in anything like a pure state, is small, compared with the mass of material worked up. The solution of the nitrates of these elements is made perfectly neutral, diluted to such a strength as to contain about 1 per cent of the oxides, and a very dilute solution of ammonia is added, about 0·1 gramme NH_3 in 500 c.c., the precipitation being conducted in large vessels, as ordinary Winchester quart bottles. The first precipitates formed are rich in samarium, and also contain much didymium; these are followed by didymium, with some lanthanum and samarium; and the final precipitates consist almost wholly of lanthanum. By this method there are obtained three portions of hydrates, which must be again worked up separately by precipitation; the first for samarium (133), the second for didymium (127), and the third for lanthanum (125), the process of fractional precipitation being repeated on each portion fifty or a hundred times.

121. The separation of the last traces of didymium from the samarium can be accomplished only by fractional precipitation, an operation so tedious that probably few chemists will be inclined to undertake it. The second portion of hydrates, consisting chiefly of didymium, is purified from the small quantities of samarium and lanthanum by fusing with potassic nitrate, as explained above for the traces of cerium (118); to separate the lanthanum the oxalates are dissolved in warm strong nitric acid, and allowed to cool, when didymic oxalate nearly free from lanthanum is obtained; after repeating several times, the last trace of lanthanum remains in the solution.

122. To separate the small quantity of didymium from the lanthanum obtained in the final precipitates with ammonia, the only method is to continue the process of fractionation; the lanthanic oxide finally obtained should be pure white, any trace of yellow showing that didymium is still present.

123. As cerite contains small quantities of the yttria earths, these must be separated from cerium, didymium, &c., by making a cold solution of the sulphates and adding finely-powdered potassic sulphate in quantity more than sufficient to saturate the solution, allowing the mixture to stand (with frequent agitation) for a few days; filtering, and washing the filtrate with a saturated solution of potassic sulphate. The filtrate contains the yttria earths, and for their complete separation it is advisable to repeat the operation with potassic sulphate three or four times. The insoluble residues, consisting of a double potassic sulphate with either cerium, didymium, or other member of this group, are boiled with sodic hydrate, filtered, well washed, re-dissolved in nitric acid, precipitated with oxalic acid, and the oxalates ignited, leaving the earths lanthana, didymia, or samaria to be finally purified as described further on.

124. The ceric oxide obtained in the manner just described was white. A considerable thickness of a strong solution did not show a trace of absorption spectrum. The atomic weight of the metal was taken and yielded the number .. .. =141·1

The number given by Bührig* .. =141·2

" " Robinson† .. =140·2

Many older determinations‡ range from 138 to 139.

This ceric oxide gave no orange-band spectrum in the radiant-matter tube, either with or without the addition of lime.

Purification of Lanthana.

125. The lanthana obtained in the manner described above (120, 122) was more difficult to purify than ceria. Long after the lanthana appeared pure, it gave in the radiant-matter tube a good orange-band spectrum when mixed with lime and treated as usual, although without lime it gave no spectrum.

So long as the lanthana showed the didymium absorption-bands I could not be certain whether the orange-band spectrum belonged to it or to didymium, therefore the tedious process of fractionation with very weak ammonia in cold dilute solutions was repeated for some weeks. The first precipitates were lanthana containing most of the didymia, whilst the final precipitates were lanthana almost if not quite free from didymia, according to the quantity originally present. After several hundred fractional precipitations repeated over and over again, a little lanthana was got which failed to show the didymium absorption-bands. As the purification progressed the phosphorescent orange-band spectrum became fainter, until finally a lanthana was obtained which, mixed with lime and treated in the usual manner, gave no orange-band spectrum whatever. This lanthana was snow-white, and had an atomic weight of 138·3. Marignac gives for lanthana 138·6, Brauner 138·28, Cléve 138·22.

Purification of Didymia.

126. The earth formerly called didymia is now known to be a mixture of didymia and samaria. The didymia which I prepared by the method described above, when mixed with lime and sulphuric acid, and tested in the radiant-matter tube, gave the orange-band spectrum as brightly as I had ever seen it. It was not, however, quite free from the accompanying samaria, and systematic operations were now commenced with the object of obtaining the didymia and the samaria in a state of purity, —that is to say, in such a condition that one of them should show no orange-band spectrum at all, whilst the other should give the spectrum in its highest degree of intensity.

I did not attempt the two purifications simultaneously on the same material. One earth only was taken in hand at a time, and by repeated fractionations and the most profuse sacrifice of material I was at last enabled to obtain a little of the desired earth quite free from admixture.

127. I took didymia first. About 1000 grms. of the earth, partially purified as described (120, 121), were dissolved in a large excess of strong nitric acid. To the nearly boiling liquid a hot saturated solution of oxalic acid was carefully added, and constantly stirred, until the precipitate, which at first rapidly disappeared, just refused to dissolve. A drop or two of nitric acid was now added to render the solution clear, and the liquid set aside to

* *Journ. Prakt. Chem.*, (2), xii., 209.

† Chemical News, vol. l., p. 251, Nov. 28, 1884.

‡ *Ibid.*, vol. xlix., p. 282, June 27, 1884.

cool, when brilliant pink-coloured prisms of didymic oxalate (containing nitric acid) crystallised out. These crystals contained nearly all the didymium and samarium, whilst the mother-liquor contained the greater part of the lanthanum — reserved for the preparation of pure lanthana (125).

The crystals of didymic oxalate were ignited and again converted into nitrate, and the above-described partial crystallisation as oxalate repeated five or six times, in each case rejecting the mother-liquor as contaminated with lanthanum.

128. The final oxalates—the ultimate cumulation of the portions least soluble in nitric acid—were next converted into nitrates, and the excess of acid driven off. The anhydrous salt was dissolved in fifty times its weight of water, and fractionally precipitated by ammonia in the following manner:—A large quantity of ammonia was first prepared of the dilution (1 to 5000) used in the previous fractionation (120), and 500 c.c. of this was gradually added, with constant stirring, to Winchester quarts about three-fourths full of the dilute didymic nitrate. In about half an hour another 500 c.c. of ammonia was again added, and this operation was repeated at intervals till the Winchester quarts were full. The bulk of the samaria comes down in the first precipitates, which are filtered off and set aside for the preparation of pure samaria (133).

To the filtrate, containing didymium, with a little samarium and lanthanum, ten successive quantities of about 200 c.c. each of dilute ammonia were added to each Winchester quart at intervals of about an hour, and after violent agitation allowed to subside. The clear supernatant liquid was now poured off, evaporated to about half its bulk, and then, when cold, again poured back into the precipitate, and the operation of precipitating with dilute ammonia was likewise repeated. By this means the greater portion of the samarium present was obtained in the precipitate, whilst the didymium left in solution contained a less proportion of samarium.

129. After a time a balance seemed to be established between the affinities at work, when the earths would appear in the same proportion in the precipitate and the solution. At this stage they were thrown down by ammonia, and the precipitated earths set aside to be worked up by the fusion of their anhydrous nitrates so as to alter the ratio between them, when fractionation by ammonia could be again employed.

Samaric nitrate decomposes by heat before didymic nitrate. The nitrates were mixed with four times their weight of potassic nitrate, and the whole kept fused in a crucible till about three-fourths of the earthy nitrates were decomposed. The cooled mass was then dissolved in water, filtered, and the solution evaporated to dryness, and again submitted to fusion. This was repeated several times.

The basic nitrates insoluble in water were dissolved in nitric acid, and put through the operation of fractional precipitation with ammonia, for samaria (133), in the manner just described above (128).

130. To remove the last traces of samarium which might have survived this treatment, the solution of nitrates which had longest resisted decomposition by fusion was now mixed with excess of potassic sulphate. The precipitated double sulphates were subjected to long washing with a saturated solution of potassic sulphate, in which the samarium salt is more soluble than the didymium salt. They were then re-converted into nitrates, and the precipitation and washing with potassic sulphate repeated several times. Finally, the didymium salt was converted into oxalate, and re-crystallised many times from nitric acid, to eliminate any trace of lanthanum that might still contaminate it. Pure didymia is of a very deep chocolate-brown colour.

These proceedings are tedious enough even in their narration, but no mere words can enable the reader to realise the wearisome character of these operations when repeated day by day, month after month, on long rows of Winchester quart bottles.

131. I commenced the purification of didymia in the latter part of the year 1883, and the operations have been going on since almost daily in my laboratory. At intervals of some weeks the didymia in the then stage of purification was tested in the radiant matter tube, a little lime having previously been added to bring out the discontinuous phosphorescence. During the first month the intensity of the orange-band spectrum scarcely diminished. After this it began to fade, but the last traces of orange band were very stubborn, and not till the last few weeks could I obtain a didymia to show no trace of the orange-band spectrum; and this result has not been accomplished without sacrifice. My 1000 grammes have dwindled away bit by bit, till now less than half a gramme represents all my store.

132. Whilst in the midst of the operations of purifying didymium and samarium I had the pleasure to receive a visit from Prof. Clève, to whom we owe so much of our knowledge of the chemistry of the samarskite and cerite metals, and especially of didymium and samarium. He gave me not only most valuable information, and suggestions respecting the work I was then engaged upon, but on his return to Upsala he munificently presented me with specimens of lanthana, didymia, samaria, yttria, and erbia—specimens at that time considered to represent a state of purity. According to any chemical tests these earths would be deemed absolutely pure, but the test of the phosphorescent spectrum proved too severe a trial, and the didymia, lanthana, and samaria all showed the orange band—the lanthana faintly, the didymia more strongly, and the samaria brightest of all. A subsequent lot of "samarium-free" didymia, sent by Prof. Cleve, also gave a strong orange-band spectrum, though the samarium present probably did not amount to more than the one hundred thousandth part of the didymium.

(To be continued.)

LECTURE EXPERIMENT.—THE FERRATES.

By C. L. BLOXAM.

THE ordinary prescriptions for preparing potassium ferrate are not well adapted for lecture illustration. It may be obtained quickly by placing a fragment of potassium hydrate in a little solution of ferric chloride, adding a few drops of bromine, and, if necessary, gently heating; the resulting dark brown mass dissolves in water, yielding a fine red solution which resembles the permanganate in its power of colouring a large volume of water, and may be kept for many hours without decomposition. Barium chloride produces a heavy purplish red precipitate of barium ferrate, leaving the liquid colourless.

A fine red solution of calcium ferrate is obtained by adding a little ferric chloride to bleaching-powder, and boiling with water. This solution also gives a purple precipitate with barium chloride. It is bleached by filtering through paper. It is well known that many samples of bleaching-powder yield a light pink solution when boiled with water, from the production of calcium ferrate; manganous sulphate destroys the pink colour, and barium chloride precipitates the ferrate.

King's College, London.
July 16, 1886.

Detection of Albumen in Urine.—P. Fuerbringer.—The author recommends the capsules prepared by Stütz, of Jena, containing a mixture of the double salt of mercuric chloride and sodium chloride with citric acid. For the same purpose H. Millard recommends a mixture of carbolic acid at 95 per cent, pure acetic acid, and potassa lye in the proportions 2 : 7 : 22.—*Zeitschr. f. Anal. Chem.*

ABSORPTION SPECTRA OF THE ALKALINE CHROMATES AND OF CHROMIC ACID.

By P. SABATIER.

The author has been for some time conducting researches based on the observation of absorption spectra, which in many cases afford a precise knowledge of the state of dissolved systems and of their progressive modifications. He has given his attention chiefly to chromic acid, the alkaline chromates, and the salts of chromium sesquioxide. His chief object has been to determine the conditions of the transformation of the green salts into the violet or into intermediate conditions.

He employs for these measurements Crova's spectrophotometer. The coloured liquid to be studied is placed in a vertical cylinder of glass, closed at the bottom by a horizontal plate of glass. A cylindrical piston of clear crystal, having the same axis as the cylinder containing the liquid, may be plunged into the latter by means of rack-work. Its position is indicated at any moment by a vernier which is movable along a graduated scale, the zero of which corresponds to the contact of the base of the piston with the flat bottom of the cylinder. This arrangement enables us to intercept between the latter and the transparent piston a liquid column of known height. For this solid piston there has been advantageously substituted a movable hollow cylinder, similar to the external cylinder, having the same axis, but a diameter twice smaller and closed in the same manner by a flat glass at its lower part. We thus can maintain the stratum of liquid traversed by the light constant in thickness, whilst varying its nature, *e.g.*, the outer cylinder receiving a solution of a coloured salt, whilst the inner cylinder contains merely the solvent. The light, directed by reflectors suitably arranged, traverses this apparatus vertically before arriving at the spectro-photometer. The author confines himself at present to indicate the results given by chromic acid and the chromates. The law generally admitted for the transmission of radiation through a thickness e is $I' = I'a^e$, a being a fraction which is known as the coefficient of transmission for the ray in question.

For greater convenience he has referred the absorption to solutions which he considers as normal, containing, per litre, 1 eq. or 50·2 grms. of CrO_3. If the light traverses a thickness of e centimetres of such a solution, we have $I' = Ia^e$.

For liquids of different concentrations the absorption will change and will depend, doubtless, merely on the mass of the compound placed in the track of the rays; on condition, however, that the initial equalisation of the two lights has been obtained in presence of one of the same depth of a colourless solvent, which has always been water. If the latter does not introduce any chemical change into the condition of the body we shall have for the energy transmitted $I' = Ia^{en}$, a being the coefficient defined above, e the depth traversed expressed in centimetres, n the number of litres occupied in the actual system by 1 equiv. of chromic acid (50·2 grms.) or by 1 equiv. of the neutral chromate $KCrO_4 = 97{\cdot}2$ grms., and 0·5 equiv. of bichromate = 73·7 grms. Thus for the solid crystalline bichromate we have $n = \frac{0{\cdot}0737}{2{\cdot}7} = 0{\cdot}0273$.

The value of a measured for the different wave-lengths with variable thicknesses are sensibly the same, which constitutes a very extensive verification of the *law of thickness*. For chromic acid the mean values of the coefficients of transmission are—

λ	a
548	0·02
555	0·137
562	0·34
569	0·623
577	0·815
585	0·905
593	0·945

The red ray is transmitted almost unaltered.

The results with potassium and ammonium bichromates are also given in the form of a table. The values found differ very little from those for chromic acid. Hence the absorption exerted by an alkaline bichromate, dissolved or solid, is sensibly identical with that produced by the chromic acid which it contains. With solutions of neutral alkaline chromates the absorption does not reach to the green rays. The absorption exerted by dilute solutions is rather greater, showing a slight dissociation into potassa and bichromate, which exerts an intense extinction upon the radiations in question.—*Comptes Rendus* (vol. ciii., p. 49).

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending June 30th, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To Colonel Sir Francis Bolton, *Water Examiner, Metropolis Water Act*, 1871.

London, July 6th, 1886.

Sir,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 175 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

The supply of water to the metropolis during the month of June has maintained the same excellent character which it has manifested now for some months past. Of the 518 samples of water examined during the past three months, no single sample was found to be otherwise than well-filtered, bright, and practically free from colour. The mean amount of organic carbon in the Thames-derived supply for the three months was 0·155 part in 100,000 parts of the water, the mean amount in last month's supply being 0·152 part, and the maximum amount in any one sample being 0·177 part in 100,000 parts of the water.

We have made mention in previous reports of experiments, which have occupied us now for some time past, on the bacteriology of stored and of running water. In the investigation of so extensive and still novel a subject, we have found it necessary to limit ourselves to an attempt at the solution of one or two special points only; and the inquiry, even thus limited, has involved us in a more than anticipated amount of experimental work. Our inquiry is indeed, even yet, far from complete; but certain results have been obtained which seem sufficiently definite to warrant our publication and discussion of them in this and succeeding monthly reports.

Leaving to others the mere determination of the relative numbers of innocuous and presumably beneficent forms of microbe life present in different examples of water-supply, we have attempted to find out something

in respect to the conditions necessary for the continued existence, development, and propagation in water, otherwise wholesome, of extraneous morbific forms purposely introduced therein, with a view to learn how far such introduced forms thrive and increase, or dwindle and die out in their environment of wholesome water, and how large or otherwise is the extent of pollution to which water must be subjected in order to allow of the introduced morbific microbes sustaining their existence therein for more than a few hours. Taking advantage of the experience common to all workers in bacteriology, as to the advisability of simplifying the experimental conditions as much as possible, and as to the paramount necessity of dealing with some or other isolated form of microbe apart from all other forms, our investigations have been conducted almost exclusively with the particular micro-organism characteristic of splenic fever, and known as *bacillus anthracis*. The mode of experimenting we have usually resorted to is as follows:—Different sorts of wholesome water were infected with a greater or less proportion of proteid liquid laden with this particular bacillus. The so-infected water having been kept at varied known temperatures for a greater or less number of hours, portions of it were added to sterilised culture-fluid or culture-jelly, and observation was made as to whether or not there occurred in the culture medium a consequent growth of bacillus. The general result was as follows:—Water which had been infected within a few hours only was found to possess the property of setting up a characteristic growth of bacillus in the culture medium to which it was added, whereas the same infected water, after it had been kept for some time longer, was found to have lost altogether this particular property. Or to state the result in another way, the existence of *bacillus anthracis* in water purposely infected with the bacillus, though abundantly evident within a few hours of the infection, was not recognisable after a longer interval. Details of some of the series of experiments made respectively with sterilised distilled water, with sterilised and decarbonated town-supply water, with sterilised but not decarbonated town-supply water, with non-sterilised town-supply water, and with non-sterilised running stream water, will be given in our future monthly reports.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

THE PURIFICATION OF WATER BY ALUM.

By Prof. PETER T. AUSTEN, Ph.D., F.C.S.

There is no subject which gives the manufacturer greater anxiety at times than the water which he is using in the works. Even where he is so lucky as to be located on the banks of some clear and sparkling brook, and hence is free from many of the troubles known to his less fortunate brethren, his brook may not seldom get into a troubled state and refuse to be clarified of its suspended clay and other matters by an ordinary process available to him. In no industry is this vexation from dirty water greater than in dyeing. Hence it is a matter of great importance, meaning a saving of hundreds and sometimes thousands of dollars, to have a simple means of clearing water, so that it can be used in ordinary manufacturing processes, and yet not in any way injure the properties of the water for subsequent use.

For large works which use water requiring continual purification, some constant process should be employed, as the Hyatt filter, for instance. The Norfolk and New Brunswich Hosieries filter all the water which they use in their works, and in this way get a most beautifully clear and sparkling water out of a rather muddy looking source (the canal). In this establishment four large Hyatt filters are used, and I have had occasion to satisfy myself of the efficacy of their working. But there are many small establishments which could not afford to put in large filters and pumps, and there are many others which do not require to purify their water, except at certain seasons of the year. Hence some simple process is needed, one that can be worked without trouble and which will give a clear water, and by which no detrimental qualities shall be added to the water.

In a recent report to the State Geologist of New Jersey on the purification of drinking water by alum, I have, in conjunction with Prof. F. A. Wilber, made this matter of the clarification of water the subject of a special investigation. The use of alum as a purifier of water seems to date back a long time. Particular attention was directed to its use by Jeunet in 1865, in an article published in the *Moniteur Scientifique*. He found that 0·4 grm. of alum to a litre of water (23·3 grains to a gallon) rendered it drinkable, even when it was quite full of foreign matter. The time taken for this clarification was from seven to seventeen minutes.

Alum is a double sulphate of potassium and aluminum, and in this case breaks into potassium sulphate, which remains in solution, and a basic aluminic sulphate. This basic aluminic sulphate, the composition of which is undetermined, precipitates as a more or less gelatinous and flocculent mass, and carries down with it the foreign matters and humus bodies. The sulphuric acid set free in the formation of the basic aluminic sulphate attacks the earthy and alkaline carbonates which are always present, and forms with them sulphates, setting the carbonic acid free. Aluminic sulphate acts like alum. Ferric chloride (perchloride of iron) acts in the same way as alum.

In late years an extensive use has been made of alum in the many processes of purifying water, sewage, &c. It is not improbable that, aside from its effect in precipitating matter mechanically by envelopment within the precipitating basic aluminic sulphate, the alum exerts a distinct coagulative action on the albuminous substances in the water, rendering them insoluble, and thus causing their precipitation; perhaps the same or similar effect that alum produces in the tawing of leather. Alum has the great advantage that it is cheap, can be obtained everywhere, and is not highly poisonous. Thirty grains can be given at a dose, and the dose repeated four times a day without danger. Then again it has another very great argument in its favour, and that is its cheapness. To get practical results from the purification by alum it is evident that it must be added in very small amounts. The amount of alum used by Jeunet seemed to be unnecessarily high. On repeating his experiments, using New Brunswick hydrant water, which at the time the experiments were made carried considerable clayey matter, we found 23·3 grains of alum to a gallon produced an immediate coagulation of the suspended matters in the water, but no settling took place under six hours or more, as stated by Jeunet. On longer standing, however, the water settled perfectly, and was as clear as could be wished for. The water after treatment had no taste of alum, but gave a perceptible test for alumina, showing that some alum remained in solution. Our next procedure was to determine what was the minimum amount of alum that was needed to clarify this particular water. Tall cylinders were filled with water and alum added in varying amounts. Depending on the amounts of alum added, gelatinous precipitates settled out after a greater or lesser lapse of time. It would be impossible to make any general rule for the addition of alum to water, because the amount of impurities will of course be very much greater in one sample of water than in another, but we were able to determine what the practical minimum limits were for this particular water. 1·2 grains of alum to the gallon was about as small an amount of alum as it seemed practical to use to get a perfect separation of the impurities. The larger the amount of alum added to the water, the more

quickly will the separation take place; the smaller the amount added, the longer will the water have to stand before a clarification will be effected. Again, large bodies of water will be precipitated by smaller amounts of alum than one would infer from experiments on a small scale, as the mechanical action of the precipitate here, in enveloping and carrying down suspended matter, is greater in a large body of water than in a small one. It will be better, however, to err on the side of too large an amount, for even then the amount of alum added will be insufficient to impart any detrimental properties to the water.

Sixteen galls. of the city water were treated with 31 grs. of alum and the whole allowed to stand. After 48 hours the precipitation seemed complete and the bottom of the vessel was covered with a brownish slimy deposit. This substance after being dried gave 59·28 per cent of ash which contained silica and alumina in relatively large amounts. The clear water gave no reaction for alumina, showing that there was no free alum in solution. The addition of more alum to the water failed to produce any further precipitation, showing that all the matter precipitable by alum had been thrown down.

It may hence be inferred that the addition of 2 grains of alum to a gallon of water will clarify it by standing. Some waters may require less, and some may require a longer standing than 48 hours, but this is a matter very easily determined for any particular case which may arise.

The water, after precipitation has taken place, is perfectly clear and sparkling, and has neither taste nor smell imparted to it. For use in the dye house there can be no possible objection made to it. The most practical way of applying this method in clarifying water for use in manufacturing where filters are not used, will be as follows. Two vats, or hogsheads, or similar deep tanks, are filled with the water and treated with alum at the rate of half an ounce of alum for every 100 gallons of water. The alum should be dissolved in a little hot water, so that it can be mixed with the large bulk of water without difficulty. The mixing can be done with a long handled dyer's stirrer. A few minutes' stirring will suffice to mix the alum and the water very thoroughly. After the mixing has been done, the water should be allowed to stand undisturbed for 48 hours or until the water clarifies, which can be easily seen by its appearance. If the clarification takes place in less time, so much the better. The water is now racked off for use. When the vat has been emptied to as low a level as is possible without disturbing the sediment, the plug in the bottom should be knocked out and the vat cleaned out with a strong jet of water. The slimy deposit is easily dislodged and washed away by a stream of water. While one reservoir is thus being used the other is full of water precipitating, so that the supply is continuous. The best means of drawing the water from the tanks without disturbing the sediment is about as follows:—The pipe should enter the side of the vat and pass to the middle and there be bent upwards so as to end about a foot above the bottom of the vat. The water is thus drawn downward, and no agitating of the bottom is produced. If the pipe is turned toward the bottom of the vat, the current of water will disturb the sediment.

I think that this method will be found of very great value to many works which now have trouble with their water in the rainy season, and I can call to mind offhand several which could use it to advantage. A few trials with the beautifully clear water produced by the alum treatment will make the hands feel loth to go back to the natural water even at its best. I am quite certain that many streams not now available to the manufacturer can be made so by this treatment.—*Textile Colorist.*

The Action of Aniline upon Orcine.—A. Zega and K. Buch.—In contact with aniline orcine loses its hydroxyl groups successively, and becoming first an oxyamine and then a diamine.—*Journ. f. Prakt. Chemie.*

NOTICES OF BOOKS.

Chemistry of the Carbon Compounds, or Organic Chemistry. By Prof. VICTOR VON RICHTER. Authorised Translation, by EDGAR F. SMITH, Professor of Chemistry, Wittenberg College, Springfield, Ohio. From the Fourth German Edition. London: H. Kimpton.

THIS book, if we may judge from the peculiarities of the orthography, has evidently been printed on the other side of the Atlantic. The language and terminology employed are also peculiar. We find the illogical term "metalloids" applied to the non-metallic elements. "Magenta" is not mentioned either in the text or in the index, the author having preferred to retain the Franco-German name "fuchsine"—unpronounceable by every Englishman who is not a German scholar. Cerulignone is here called "cœrculignone." *Carthamus tinctorium* is another peculiarity; the plant is commonly known as *Carthamus tinctorius*. Extract of indigo is spoken of as indigo-carmine, and in the same paragraph we read—"Or the indigo-blue is changed by fermentation to indigo-white, *the weaving* saturated with the latter, &c." Now "the weaving" is certainly a literal version of the German original "das Gewebe," but the idiomatic and intelligible English rendering would be "the tissue." In the section on Uric Acid we find the unusual terms "Carnivoræ" and "Herbivoræ." In short, the reader will occasionally feel tempted to remark that Prof. von Richter's work might well have claimed a more careful translation.

The author's object has evidently been to produce a text-book holding a somewhat intermediate rank between those sketchy manuals with which we are but too familiar and such works as those of Professors Roscoe and Schorlemmer. As far as was possible within the compass of 694 pages he has been fairly successful. The index might have been advantageously rendered more complete.

First Lessons in Practical Chemistry: an Introduction to the Study of Qualitative Analysis. By A. HUMBOLDT SEXTON, F.C.S., Professor of Chemistry in the College of Science and Arts, Glasgow. Glasgow: Hadden.

WE have here a pamphlet of 32 pages. The author complains that the course of practical laboratory work usually followed has been subjected to several attacks and denounced as "test-tubing." He admits that it is "open to grave objections, one of the most important being that it is often quite impossible to say how far the results entered in the laboratory-book have been actually observed, or how far they have been copied from the text-book." He has therefore drawn up his exercises in such a manner as to ensure, as far as possible, that the student may actually observe the facts which he records. He expresses strong doubts as to the expediency of putting even simple quantitative experiments into the hands of beginners.

The teachings of the book are divided into twenty-five lessons, followed by instructions on the preparation of reagents. Here we perceive that whilst the possible impurities of sulphuric acid are noticed, those which may occur in hydrochloric and nitric acids are overlooked, and that ammonia is altogether omitted.

The Retrospect of Medicine. A Half-yearly Journal, containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by JAMES BEAITHWAITE, M.D. Lond. Vol. xciii. Jan. to June, 1886. London: Simpkin, Marshall, and Co.

THIS volume contains little which can legitimately claim our notice. Lead poisoning seems to be attracting considerable attention. None of the cases here referred to, however, seem traceable to the use of water which has

traversed lead pipes or has stood in lead cisterns. Cocaine, now so fashionable, seems to possess well-marked poisonous properties, though no fatal case is recorded.

Annual Report of the Board of Regents of the Smithsonian Institution: showing the Operations, Expenditures, and Condition of the Institution for the Year 1884. Washington: Government Printing-Office. 1885.

This volume contains some curious facts concerning Smithson, the founder of the Institution. His name appears to have been Macie, but he assumed, by Royal license, the name of his putative father, Smithson, curiously designated the *first* Duke of Northumberland.

The energy with which Americans are carrying on scientific exploration in all parts of the world is highly deserving of honour, the more as it is not a mask for covering military and political intrigues. We notice here the proposal made by Prof. V. Ball, of the University of Dublin, that an Institution like the Smithsonian would be very useful in England.

The "Record of Scientific Progress" is an important and elaborate feature, but the facts laid down are of course by this time generally known. Of this report 174 pages are devoted to meteorology, whilst physics claims only 56 and chemistry 51.

City and Guilds of London Institute for the Advancement of Technical Education. Report to the Governors, 1886. Gresham College, E.C.

Among the efforts now being made to place technical training in England in a position commensurate with the necessities of our national position, the establishment and maintenance of the City and Guilds of London Institute occupies a position of increasing importance. The Report before us expresses the hope that "the advantages offered by the Central Institution will enable parents to secure in England for their sons Technical Instruction of the same high class as has been for so many years provided in the great Technical Colleges on the Continent: it is hoped that students trained in the Central Institution will gradually occupy the places in manufacturing works, and especially in Chemical works, both in England and the Colonies, which now for some years have been almost monopolised by the Germans and the Swiss."

That such may be the case we most devoutly trust; but to ensure the success, in its highest sense, of the Institution something more than a sufficiency of funds will be requisite. Two evils in the character of the teachings given will have to be avoided. One of these is the teaching of processes to the exclusion of principles, forgetting that processes may be improved upon or superseded, whilst principles are always applicable. The other danger is one peculiarly English; it consists in teaching the student to talk about things rather than to do them. This is an inevitable consequence of the exaggerated importance which in these realms—and nowhere else save in China—is attached to examinations. What is wanted is that, as was well said by Prof. H. E. Armstrong last year in his Presidential Address to the Chemical Section of the British Association, "an atmosphere of research must pervade the College." Whatever stands in the way of this end must be sacrificed without scruple.

Prix Courant Général des Produits Chimiques et Pharmaceutiques. Paris: Billault, 22, Rue de la Sorbonne.

This establishment, the successor to the firm of Billault and Billandot, as well as to Robiquet and the Pelletiers, issues a very complete price list of drugs and chemicals. We find here aluminium carbonate—a substance lately patented in this country as a precipitant for sewage—offered at 3 francs per kilo. Vanadium still maintains its rank as the costliest product which comes into the hands of the chemist; it is quoted at 70 frs. per grm., or more than seventeen times the price of chemically pure gold. Metallic cerium figures at 40 frs. per grm. A curious product, which we have never met with before in any price-current, is chitine, obtained from coleopterous insects. Phenol-phthaleine, which is strangely absent in some catalogues which have reached us, is quoted at the very reasonable figure of 20 centimes per grm.

The least satisfactory point in this list is that salts are classified under their constituent acids, and are thus often inconveniently removed from their bases.

CORRESPONDENCE.

PROF. DITTMAR'S "ANALYTICAL CHEMISTRY."

To the Editor of the Chemical News.

Sir,—In looking over the notice of this useful little book in your issue for the 9th inst. (Chem. News, vol. liv., p. 21), I saw with equal surprise and regret that I have described the first part as being substantially unaltered whilst the appendix had been re-written; the reverse is to a great extent the case.—I am, &c.,

Your Reviewer.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 1, July 5, 1886.

Electro-Conductivity of Mixtures of Neutral Salts. E. Bouty.—The author notes that no general rule enables us to deduce exactly the conductivity of mixtures of neutral salts from that of simple saline solutions. He inclines to the opinion that the difficulty of the problem depends not on the nature of electro-conductivity itself, but on the variability of the chemical equilibria possible in solutions.

Decomposition of Ferric Chloride by Water.—G. Foussereau.—In the decomposition of this salt by water two very distinct reactions may be produced. On the one hand the acid and the base separate, giving rise, by a reversible phenomenon, to soluble hydrated products, the formation of which is shown by a reddish colouration of the liquid. On the other hand, a portion of the oxide or of the oxychloride separated may undergo a molecular modification and be precipitated as an insoluble oxide. This latter effect is not reversible and does not occur in very dilute liquids.

Absorption-Spectra of the Alkaline Chromates and of Chromic Acid.—P. Sabatier.—(See p. 44).

Transformation-Heat of Vitreous Selenium into Metallic Selenium.—Ch. Fabre.—The mean quantity of heat liberated in the change of state of selenium is +2·88 calories.

Action of Vanadic Acid upon the Alkaline Haloid Salts.—A. Ditte.—The author has studied the behaviour of vanadic acid with potassium iodide, bromide, chloride, and cyanide. With the haloid salts of sodium and ammonium the reactions are quite similar, but the fluorides form an exception.

On Barium Hydrate.—M. de Forcrand.—The author has previously obtained and described two crystalline compounds obtained on dissolving anhydrous barium

oxide. He now finds that these crystals, if heated at 135° in a current of dry hydrogen, lose 31·85 per cent of their weight, and leave normal barium hydroxide still contaminated with 3 to 4 per cent of methylic alcohol.

Contribution to the Study of the Alkaloids.—Oechsner de Coninck.—Synthetic quinoleine iodomethylate and pyridin iodomethylate are mixed in equimolecular proportions. The mixture is dissolved in hot hot absolute alcohol, adding an excess of potash lye at 45°, when the liquid turns from bright red to reddish brown. It is heated in the water-bath for an hour, when a brownish resin is formed. The liquor is decanted into another flask, a little potassa is added, and heat is applied for an hour longer. The resin is allowed to drain and is then dissolved separately in methylic, ethylic, and amylic alcohols and in ether. The solutions thus obtained are all reddish brown by reflected, but a fine ruby-red by transmitted light. The next day there is found in the second flask a viscous mass, which is exhausted with hot absolute alcohol and filtered through fine paper. The filtrate is of a garnet-red. Its reactions distinguish the colours described in the author's last memoir from those now described. He has prepared in the same manner the derivative colours from various isomeric mixtures. The colours vary not merely with the nature of the alcoholic radicle combined, but with the position which it occupies in the compound. He has examined, also, the iodomethylates of dipyridin, α-dipicoline, β-dipicoline, β-dilutidine, and γ-dilutidine.

Isomerism of the Camphols and Camphors.—Alb. Haller.—The author tabulates the camphols of N'gai, of mother-wort, and Bang-phien, each with its corresponding camphor, monobromo-camphor, and camphoric acid, showing their respective fusion-points and rotatory powers.

Researches on the Composition of the Suint of Sheep's Wool.—A. Buisine.—The author refers to the complex nature of suint, consisting of two distinct portions, the sudoric and the sebaceous secretions. The former portion is soluble in pure water, whilst the latter is removed from the wool only by means of soap-lyes, &c. The sudoric liquid of the sheep holds in solution free carbonic acid; ammonium and potassium carbonates; fatty volatile acids, the acetic, propionic, butylic, valerianic, and caproic; fatty acids higher in the series, especially the œnanthylic and capric; oleic and stearic acids and certain waxy acids, among which is the cerotic. These acids exist in the suint-washings in the state of potash soaps. There is further suint-grease in the state of emulsion, phenol as potassium phenylsulphate, sarcolactic, benzoic, oxalic, succinic, and uric acids; amidic acids, glycocoll, leucine, and tyrosine, and colouring-matters analogous to those of urine.

Acidimetric Determination of Sulphurous Acid.—Ch. Blarez.—From the author's experiments it appears that sulphurous acid does not behave in the same manner with the various alkalimetric indicators. With phenolphthalein it possesses a basicity twice as great as with cochineal, helianthine, and acid magenta. The last-mentioned indicator indicates only the partial neutralisation of sulphurous acid when the neutralisation of the first half has been slightly exceeded. Litmus, Poirrier's blue C4B, as well as baryta-water and ammonia, do not give distinct results.

Acidimetric Determination of the Apparent Acidity and Acidimetric Determination of the Sulphurous Acid.—Each c.c. of the decinormal alkaline liquid represents 0·0032 grm. of SO_2 if we use phenolphthalein or 0·0064 grm. SO_2 if we employ cochineal or helianthine. The following are the results of direct determinations, giving the quantity of SO_2 in weight per litre:—Titration with iodine, 3·840 grms.; with phenolphthaleine, 3·776 grms.; with cochineal, 3·792; and with helianthine, 3·795. Hence the acidimetric determination of sulphurous acid is sufficiently exact whenever possible. The acidimetric determination of free sulphurous acid in presence of other free acids is practicable only in case of a mono or polybasic acid so strong that its absolute basicity can be shown by cochineal or helianthine. In this case we make two successive determinations, one with cochineal or helianthine and the other with phenolphthalein. The difference expressed in c.c. of decinormal alkali multiplied by 0·0064 gives the weight of sulphurous anhydride in the volume of the solution operated upon. This method has been verified in presence of nitric acid (added at the very moment of titration) hydrochloric, sulphuric, and oxalic acids. The results were in every case satisfactory. This method is applicable also in the titration of sulphites and in the study of their aqueous solutions. The acid sulphites with an excess of sulphurous acid appear acid to cochineal and helianthine. With these reagents and a standard alkali their excess of sulphurous acid may be determined. The acid sulphites are neutral to cochineal and helianthine; if mixed with phenolphthalein they appear acid, and they absorb, before showing the rose colouration which this reagent takes in contact with bases, as much alkali as they already contain. The neutral sulphites, alkaline with respect to cochineal and helianthine and neutral to phenolphthalein, are brought to the state of acid sulphites by an addition of sulphurous acid equal to that which they already contain. It is preferable, however, to employ decinormal hydrochloric acid. A slight excess of this liquid is added, making use of cochineal or helianthine, and it is brought back to the turning-point with decinormal alkali. If we have an intermediate sulphite containing, for 1 mol. of sulphurous acid more than 1 but less than 2 mols. of alkali, we may find its exact composition by means of the two following determinations:—*a*, to a given volume of the solution is added standard alkali until the phenolphthalein changes colour; *b*, to a similar volume of the same solution is added an excess of decinormal hydrochloric acid so as to pass the turning-point of cochineal or of helianthine, and the excess is determined by the addition of decinormal alkali. The sum obtained by the addition of the volume of alkali used in *a* and of the volume of acid really utilised in *b*, calculated as sulphurous acid, shows the quantity of this body contained in the volume of liquid operated on. Now, as we know the weight of sulphurous acid contained in a given volume of liquid and the weight of alkali necessary to transform it into a neutral sulphite (experiment *a*) we find by difference the weight of combined alkali and consequently the exact composition of the compound.

Development of the Sugar-Beet; Study of the Leaves.—Aimé Girard.—Not susceptible of useful abstraction.

Justus Liebig's Annalen der Chemie, Vol. ccxxxiii., Part 2.

On the Uranium Compounds.—G. Alibegoff.

Separation of Uranium from the Alkaline Earths and Alkalies and its Determination.—G. Alibegoff.—In the second of these memoirs the author shows that neither ammonium sulphide, nor ammonium carbonate followed by ammonium oxalate, as proposed by Foulon, can be successfully used for separating uranium from calcium. He recommends mercury oxide with the addition of ammonium or sodium chloride. The precipitate is washed with a very dilute solution of ammonium chloride. For the determination of uranium a measured quantity of solution of uranyl chloride is mixed with a few drops of ammonium chloride in a beaker and heated to a boil; pure elutriated mercury oxide is then added, carefully avoiding excess. The liquid is then brought again to a boil, shaking occasionally. Stirring with a glass rod is not recommended, as the precipitate attaches itself firmly to parts of the beaker which have been rubbed with the rod. The beaker is let stand in cold water until cold. The clear supernatant liquid is then repeatedly decanted off, the precipitate is brought upon the filter and washed with

water containing ammonium chloride. All this must be done in the cold. The use of the filter-pump cannot be recommended. The washed precipitate, together with the filter, are placed in a platinum crucible and heated, at first cautiously, then gradually to ignition, the lid being removed, and finally converted by the blast-lamp into olive-green uranoso-uranic oxide, in which form it is weighed. In the separation of uranium from calcium and strontium, a small quantity of the latter may be carried down, if they are present in excess, but they may easily be removed by boiling up the precipitate after decantation a couple of times with water containing sal-ammoniac, and filtering when cold. The slightest trace of the alkaline earths in the precipitate may be recognised by the presence of yellow or orange-coloured particles in the olive-green mass after ignition. The separation of barium from uranium is preferably effected by means of sulphuric acid. To mixtures of the chlorides of uranium and magnesium there is added first a sufficiency of ammonium chloride, and the mixture is boiled up. On the subsequent addition of mercury oxide uranium is deposited alone. If alkaline earths occur along with alkalies and uranium mercury oxide may be used with success.

Communications from the Laboratory of the University of Graz.—These include a memoir by Alfred Popper on the Atomic Weight of Antimony. The author in his latest and most careful determinations obtains a mean value of 120·69, or an entire unit more than J. P. Cooke's result, 119·60. He can find no source of error either in Cooke's determinations or in his own, and suggests that the possible presence of germanium may solve the question. From the same laboratory we have an account of nickel-carbide, by L. Pebal, and a note by Fr. Iwig and O. Hecht on the calcium salts of malic acid.

Communication from the Main Chemical Laboratory of the University of Tubingen.—This consists of an investigation by A. Römer on the influence of volumes upon the chloration of combustible gases.

Communications from the Chemical Laboratory of the University of Geneva.—These include a paper by A. Rée on β-sulphophthalic acid, β-oxyphthalic acid, and β-chlorophthalic acid, and a memoir by C. Graebe and Ph. Guye on the formation of diphthalyl.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 2, 1886.

Examination of Mixed Tissues and Yarns.—A. Gawalowski.—The author determines actual solids on 2·5 grms. by drying at 100° in a special apparatus. The fat is obtained by extracting 15—20 grms. of the sample, gently dried, with the purest petroleum ether, evaporating and weighing the residual fat. Soaps, resin, alkali, pigments, &c., are obtained by extracting the sample freed from fat, first with boiling water and then with a mixture of 2 parts absolute alcohol and 1 part ethylic ether. The residue is dried at 100° and weighed. To determine wool this residue is steeped for 12 hours in a cold acid containing 60 per cent. of sulphuric anhydride, carefully transferred to three times the volume of cold water, filtered, perfectly washed with hot water and weighed as wool. The difference is cotton, linen, hemp, or silk waste.

Examination of Manures and Soils.—H. H. B. Shepherd, P. de Gasparin, G. Lechartier, A. Carnot, &c. —From the Chemical News, *Comptes Rendus*, and other publications.

Separation of Chlorophyll.—Tschirch.—(*Chemiker Zeitung*). This may be effected by precipitating the green alcoholic solution with solution of barium hydroxide.

Solubility of Calcium Phosphate in Urine.—A. Ott. —Neutral calcium phosphate requires the presence of salts, which increase its solubility, to explain the proportion in which it is found in urine.

Titration of Urea with Bromine Lye (Hanburger's Method).—E. Pflüger and F. Schenck.—The process does not give satisfactory results.

Determination of Nitrogen and Chlorides in the Urine of Dogs.—As regards nitrogen Kjeldahl's method gives comparable results. The determinations of the chlorides made according to Habel, Fernholz, Arnold and Mering are also concordant.

On the Multiplier in Determining Sugar in Urine. —Worm-Müller.—The multiplier 230 is found sufficiently accurate for urines containing more than 0·5 per cent of sugar.

On Mucus-Matters.—O. Hammarsten.—The mucine of snails is a mixture of true mucine and mucoid matters.

A Method for Determining the Relative Proportions of Pepsine.—E. Schutz.—This memoir does not admit of useful abstraction.

The Acrid and Volatile Constituents of certain Ranunculaceæ.—H. Beckurts.—(*Chemiker Zeitung*). The author has examined the components of *Anemone nemorosa*, *A. pratensis*, and *A. pulsatilla*.

Relation of Silver to the Chlorides and Bromides of the Alkali Metals.—J. S. Stas.—The author's determinations, taking O=16, are—K=39·1425, Na=23·0455, N=14·0550, Ag=107·9300. If we assume O : H=15·96 : 1, we have K=39·044, Na=22·988, N=14·019, Ag=107·660

Equivalent Weight of Titanium.—T. E. Thorpe.— The mean value obtained is 48·013.

Atomic Weight of Platinum.—W. Halberstadt.— The author's mean result leads to the value 194·57592.

Moniteur Scientifique, Quesneville.
3rd Series, Vol. xvi., June, 1886.

Methylene Blue.—M. Bernthsen.—Translated from Liebig's *Annalen*.

The Manufacture of Toilet Soaps.—C. R. Alder Wright, F.R.S.—Translated from the *Journal of the Society of Arts*.

Industrial Review and Patents.—Extracts on the manufacture of ceresine from ozokerite (*Chemiker Zeitung*); on an alloy of 80 parts of lead with 20 parts of tin recommended in *Chemische Industrie* as resisting acids; on the influence of the composition of glass upon the variations of the thermometric scale, from the *Chemiker Zeitung*; on benzylmethylaniline and on a green colouring derivative, from the *Journal of the American Chemical Society* and abstracts of patents on improvements in smelting metals by means of electricity, by E. and A. Cowles; the preparation of white-lead by means of magnesium acetate and lead oxide, by Dr. W. Kubel; a process for deodorising mineral oils by treatment at a boiling heat with sulphurous acid, by Dr. A. Faulbaum; the preparation of a green colouring-matter by nitrating the Liebermann's phenolic colouring-matter; on an orchil-red azo colour; and on the use of the thiodiphenylamine and its ethyl and methyl derivatives for preparing colouring-matters.

Solubility of Antimony Oxide in Alkaline Solutions of Glycerine: New Mordant for Cotton-Dyeing.— Dr. Koehler.—The author dissolves caustic soda in an equal weight of distilled water, adds 100 grms. glycerin, and introduces antimony oxide, as a paste containing about 60 per cent of Sb_2O_3 until a notable quantity remains undissolved. The operation requires 1 hour, and the most suitable temperature is 80°. The antimony oxide used should be free from sulphide. This liquid is used as a substitute for tartar emetic in fixing tannin upon the fibre of cotton.

Germanium.—Dr. Quesneville.—The writer appeals to Dr. Winckler to give to his new element—here spoken of as a metal—the name of ekasilicon in place of germanium.

Notes on Cocaine and Hopeine.—From *Chemische Industrie* and the *Chemiker Zeitung*.

Analysis of the Fertilising Matters known as Commercial Manures.—This report has already appeared in the Chemical News.

Artificial Colouring Matters Applied in Industry.—The fifth of Prof. Noelting's course of lectures, describing the anthracene derivatives.

Properties and Proprietors of Ungreenable Aniline Black.—S. Grawitz.—A reply to a recent letter by M. Camille Kœchlin.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 11, June 5, 1886.

Letter to the President of the Chemical Society.—P. Cazeneuve.—A brief controversial note on the use of metallic oxides for detecting coal-tar colours in wines.

On Two Properties of the Urethanes of the Fatty Series.—G. Arth.—Borneol and menthol carbamates do not form an exception to the general rule, but present the characters of other compounds of this class if studied in the same conditions.

Action of Alcoholic Potassa upon Urea, Sulphurea, and certain Substituted Ureas: A Reaction, the Inverse of that of Wœhler.—A. Halber.—Urea, both the natural product and the artificial kind, obtained by Wœhler's process if heated in sealed tubes with alcohol and potassa, is split up into potassium cyanate, ammonia, and water. Monoethylurea treated in the same manner is split up into potassium cyanate, ethylamine and water. Unsymmetric diethylurea yields potassium cyanate and diethylamine. Sulphurea forms ammonium sulphocyanide and sulphide, whilst a large part of the sulphurea remains unattacked.

On a Basic Copper Arseniate.—M. Coloriano.—The author has obtained the compound $As_2O_5 3CuO$ in slender laminæ or in isolated prisms.

Researches on certain Crystalline Arseniates.—M. Coloriano.—The author has obtained crystalline compounds of arsenic acid with zinc, manganese, and copper.

On Tellurous Anhydride and its Combinations with the Acids.—Daniel Klein.—The author examines the two varieties of tellurous anhydride, that prepared by the moist way and that crystallised by fusion. The former has the specific gravity 5·67, 5·65, 5·68, whilst the latter =5·915. He has determined the crystalline form of tellurium nitrate; obtained and examined potassium hexatellurite and the double potassium and telluryl, sodium and telluryl, lithium and telluryl, and barium and telluryl tartrates.

Journal für Praktische Chemie.
New Series, Vol. xxxiii., Parts 10 and 11.

On the Constitution of the Platinum Bases.—S. M. Jörgensen.—This extensive memoir is quite incapable of useful abstraction within the space at our disposal.

A Contribution to our Knowledge of the Nature of the Setting of Cements.—Dr. E. Michel.—The author's experiments lead to the conclusion that the setting of cement depends: on the addition of water, which must be as moderate and as uniform as possible; on the density and on the most intimate mixture of the materials; on the formation of calcium carbonate. The proportion of lime for hardening needs to be but slight. All the three main constituents of cement, silica, alumina, and lime, are chemically active. Alumina determines the quick loosening and silica the permanent setting. Alkalies take no essential part in setting.

Two Reactions of Morphine.—Dr. J. Donath.—The first mentioned reaction is a completion of that of Tattersall (Chem. News, xli., p. 63), by means of sulphuric acid and potassium arseniate. Finely-ground morphine (about 1 m.grm.) is well rubbed up with 8 drops of sulphuric acid in a porcelain capsule; a granule of potassium arseniate is added and stirred up together with the other materials. If the mixture is then heated over a small flame, shaking it all the time until acid vapours begin to escape, a fine violet blue colouration appears, which on further heating turns to a dark brownish red. On cautious dilution with water there appears a reddish colouration, which turns green on the further addition of water. If this liquid is poured into a test-tube, chloroform being added, and the whole shaken, the latter takes a splendid violet colour. Ether likewise takes a splendid violet-red, whilst the supernatant stratum is brown. Dehydromorphine, on the other hand, on rubbing up with sulphuric acid and potassium arseniate, becomes a dirty green, which turns brown on heating intensely green on dilution with water. This solution gives up no colouring matter to chloroform. The second reaction is effected with sulphuric acid and potassium chloride, and resembles the ferric-chloride reaction. A little morphine rubbed up with about 8 drops of strongest sulphuric acid turns grass green in the cold on adding a drop of a solution of 1 part of potassium chlorate in 50 parts concentrated sulphuric acid. The colour is very persistent, and at the margin of the liquid there appears a faint rose colouration. Dehydromorphine similarly treated becomes a brownish green.

On the Combustion-Heat of Benzol.—Julius Thomsen.

Reply to the Foregoing Memoir.—F. Stohmann.—A controversy with reference to certain experiments of H. F. Stohmann described in this Journal (vol. xxxiii., p. 241), each disputant taking exception to the method of the other.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Analyses of Two Samples of Rock-Salt from Northwich.—By Rowland Williams, F.C.S.—

	No. I. Per cent.	No. II. Per cent.
Sodium chloride	99·761	99·247
Calcium	0·094	—
Magnesium	0·145	0·213
Potassium	trace	trace
Sodium sulphate	—	0·009
Calcium sulphate	—	0·082
Insoluble matter, clay, &c.	—	0·401
Organic matter	—	0·048
	100·000	100·000

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THE CHEMICAL NEWS.

Vol. LIV. No. 1392.

PROBABLE ISOLATION OF FLUORINE. DECOMPOSITION OF HYDROFLUORIC ACID BY AN ELECTRIC CURRENT.

By M. H. MOISSAN.

In a former memoir* we showed that it was possible to decompose anhydrous hydrofluoric acid by the action of an electric current: at the negative pole hydrogen collects; at the positive pole a gaseous body is disengaged having novel properties. The experiment was performed in a platinum U-tube, closed by stoppers of fluorite, and having at the upper part of each branch a small delivery tube, also of platinum. Through the stopper passes a platinum rod, which acts as electrode; the metal employed for the positive pole is an alloy containing 10 per cent of iridium.

To obtain pure anhydrous hydrofluoric acid we begin by preparing fluorhydrate of fluoride of potassium, taking all the precautions pointed out by M. Frémy. When the salt is obtained pure it is dried on a water-bath at 100°, and the platinum capsule containing it is then placed in a vacuum in the presence of concentrated sulphuric acid, and two or three sticks of potash fused in a silver crucible. The acid and potash are renewed every morning for a fortnight, and the vacuum is kept at 2 c.m. of mercury. Care must be taken during this desiccation to pulverise the salt every day in an iron mortar, so as to renew the surface. When the fluorhydrate contains no more water it falls to powder, and is then fit to serve for the preparation of fluoric acid; the fluorhydrate of fluoride of potassium, if well prepared, is much less deliquescent than the fluoride.

When the fluoride is quite dry it is quickly introduced into a platinum alembic which has just been dried by heating it to redness. The whole is kept at a gentle temperature for an hour or an hour and a half, so as to allow the decomposition to commence very slowly; the first portions of acid which come over are rejected, as they carry with them traces of water remaining in the salt. The platinum receiver is then attached, and the heat increased, allowing the decomposition to proceed with a certain degree of slowness. The receiver is then surrounded with a mixture of ice and salt, and from this moment all the hydrofluoric acid is condensed as a limpid liquid, boiling at 19·5°, very hygroscopic, and, as is well known, giving abundant fumes in presence of the atmospheric moisture.

During this operation the platinum U-tube, dried with the greatest care, has been fixed with a cork in a cylindrical glass vessel surrounded with chloride of methyl. Up to the moment of introducing the hydrofluoric acid the leading tubes are attached to drying tubes containing fused caustic potash. To introduce the hydrochloric acid into the apparatus, it may be absorbed through one of the lateral tubes in the receiver in which it is condensed.

In some experiments we have directly condensed the hydrofluoric acid in the U-tube surrounded with chloride of methyl; but in this case care must be taken that the tubes are not clogged up by small quantities of fluoride carried over, which would infallibly lead to an explosion and projections, which are always dangerous with so corrosive a liquid.

When we have introduced in advance in the small platinum apparatus a determined amount of hydrofluoric acid, cooled with chloride of methyl, in tranquil ebullition at a temperature of −23°, the current of 20 cells of Bunsen large size, arranged in series, is passed through by means of the electrodes. An ampère meter in the circuit admits of the intensity of the current being observed.

If the hydrofluoric acid contains a small quantity of water, either by accident or design, there is always disengaged at the positive pole ozone, which has no action on crystallised silicium. In proportion as the water contained in the acid is thus decomposed, it is seen by the ampère meter that the conductivity of the liquid rapidly decreases. With absolutely anhydrous hydrofluoric acid the current will no longer pass. In many of our experiments we have succeeded in obtaining an acid so anhydrous that a current of 25 ampères was entirely arrested.

To render the liquid conducting we have added before each experiment a small quantity of dried and fused fluorhydrate of fluoride of potassium. In this case decomposition proceeds in a continuous manner: we obtain at the negative pole hydrogen, and at the positive pole a regular disengagement of a colourless gas in which crystallised silicium in the cold burns with great briliancy, becoming fluoride of silicium. This latter gas has been collected over mercury, and accurately characterised.

Deville's adamantine boron burns in the same manner, but with more difficulty, becoming fluoride of boron. The small quantity of carbon and aluminium which it contains impedes the combination. Arsenic and antimony in powder combine with this gaseous body with incandescence. Sulphur takes fire in it, and iodine combines with a pale flame, losing its colour. We have already remarked that it decomposes cold water, producing ozone and hydrofluoric acid.

The metals are attacked with much less energy. This is due, we think, to the small quantity of metallic fluoride formed preventing the action being very deep. Iron and manganese in powder, slightly heated, burn with sparks. Organic bodies are violently attacked. A piece of cork placed near the end of the platinum tube, where the gas is evolved, immediately carbonises and inflames. Alcohol, ether, benzol, spirit of turpentine, and petroleum take fire on contact.

The gas evolved at the negative pole is hydrogen, burning with a pale flame, and producing none of these reactions.

When the experiment has lasted several hours, and there is not enough hydrofluoric acid left at the bottom of the tube to separate the two gases, they re-combine in the apparatus in the cold, with violent detonation.

We have satisfied ourselves, by direct experiment, that a mixture of ozone and hydrofluoric acid produces none of the reactions described above.

It is the same with gaseous hydrofluoric acid. Finally we may add that the hydrofluoric acid employed as well as the hydrofluorate of fluoride were absolutely free from chlorine.

The gas obtained in our experiments is therefore either fluorine or a perfluoride of hydrogen.

New experiments are necessary to settle this last point. We hope soon to lay the results before the Academy.—*Comptes Rendus*, vol. ciii., p. 202, July 19, 1886.

Micro-organisms of Potable Water and their Life in Carbonated Waters.—T. Leone.—The fresh water from the Munich city works, which contains no traces of nitrites, nitrates, or ammoniacal salts, gives, per litre, a residue of 284 m.g., whilst the organic matter in the same quantity is oxidised by 0·99 m.g. of oxygen. This water contained, when fresh, only 5 microbia in 1 c.c.; in twenty-four hours the number had reached 100; in two days 10,500; in three days 67,000; in four days 315,000; and in five days more than half a million. In water saturated with carbonic acid the number of microbia, on the contrary, decreases.—*Biedermann's Centralblatt*, Pt. 3.

* *Comptes Rendus*, vol. cii., p. 1543, and Chemical News, vol. liv., p. 36.

THE REDUCTION OF FERRIC NITRATE IN THE NITROMETER.

By THOMAS BAYLEY.

I HAVE already stated that when ferric nitrate is shaken in the nitrometer with pure sulphuric acid a tint is produced which varies from "dark" port wine red to "reddish" or "pink," according to the amount of iron present. The term "raspberry," used by Prof. Lunge, expresses the tint very well for a certain stage of dilution. Prof. Lunge has obtained this tint by adding ferric nitrate to the liquid within the nitrometer, but has failed to discover any reduction to ferrous salt. He does not, however, offer any explanation of the appearance of the tint, nor any reason why it was not obtained in his second experiment. If it is not caused by a proto-salt of iron, what is the nature of the raspberry compound?

The colour produced with a ferric is identical with that which appears when a ferrous salt is directly employed, but in neither case is there any resemblance to a chocolate tint until after dilution with water. If crystals of nitre and ferrous sulphate are covered over with concentrated sulphuric acid in a test-tube the wine red or raspberry reaction is obtained: it is therefore not peculiar to the nitrometer.

With respect to the test for the ferrous salt with potassium ferricyanide, Prof. Lunge says:—"Of course, if the liquid were treated with that reagent just after being diluted, and therefore quite hot and containing an enormous excess of acid, it would turn blue with potassium ferricyanide. but no one acquainted with qualitative analysis will work that way." I am prepared to admit that this result is possible, but I have tried the experiment some half dozen times with concentrated acid and with mixtures of equal volumes of acid and water while still quite hot, without the production of a green or blue tint on any occasion.

This, however, is of no consequence in the present instance, as my tests have not been made in the way Prof. Lunge describes.

For the benefit of persons interested in qualitative analysis, it may be worth while to describe the exact process whereby the existence of the ferrous salt, and therefore the reduction of the ferric salt, can be demonstrated. If after the appearance of a dark raspberry tint the nitric oxide be expelled, and cold but recently boiled distilled water be added through the tap, the vitriol can be diluted without contact with air. If after cooling this dilute liquid is caused to flow along the channel drilled axially through the tap into a dilute and freshly-prepared solution of the ferricyanide of potassium, the blue colour instantly appears. The experiment can be repeatedly performed successfully when only a very few milligrammes of iron are present, if only a suitable quantity of ferricyanide be employed. Dilution of the vitriol while exposed to air occasions rapid and sometimes almost instantaneous oxidation, owing to the temperature and the presence of the oxide of nitrogen. I have by this method shown the reduction of ferric nitrate to several chemists, to their entire satisfaction.

One point alone remains for discussion, namely, whether commercial nitrous vitriol ever contains sufficient iron in any shape to dissolve a measurable quantity of nitric oxide. I am familiar with the working of seven chambers which are connected in series and have one Glover and one Gay-Lussac tower. The acid from the absorber circulates of course through the Glover and the excess is passed into certain chambers of the series. On the 19th inst. a sample of the Glover acid was nitrous, and 8 c.c. of it gave the tint of a dark ripe raspberry and liberated 3·0 c.c. of nitric oxide. After expelling the gas and leaving the liquid standing over the mercury for 24 hours no more oxide of nitrogen was liberated on further shaking. But on adding about 8 c.c. of water gas was evolved which measured 5 c.c. when cold. The liquid was now of chocolate colour, and judging from my former experiments probably contained 1 c.c. of gas. The amount set free by water was thus one-sixth of that disengaged by the first shaking and was certainly a measurable quantity. This sample of Glover acid was doubtless similar to those described in Prof. Lunge's book on alkali as depositing a crust of ferric nitrate during concentration, but even where the amount of iron is smaller and the extra gas hardly measurable, it does not follow that the *dissolved* portion is quite insignificant in amount. Prof. Lunge has now "closed his account in this matter" of the nitrometer, but doubtless still "lives to fight another day" with a more worthy adversary; and I am fain to close my account too, but not without an expression of thanks to the editor of this journal for the opportunities of discussion he has so liberally afforded, and to Prof. Lunge for the patient manner in which he has contributed to the controversy since my original statement of *fact*.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

TWENTY-FIVE years ago M. Stas commenced publishing the results of his researches on the atomic weights of silver and some other bodies. Five years later, that is in 1865, in an extended memoir which M. de Marignac described as beautiful, magnificent, immense, he completed and amplified these estimations. Having submitted the wet method of Gay-Lussac to a fresh examination, M. Stas published his researches on the chloride and bromide of silver, the study of which, in spite of its difficulty, is indispensable in order to properly appreciate his "Memoir on the Proportional Relation between Silver and its Chlorides and Bromides." This last work, although presented to the Academy of Brussels in 1876, was not printed until six years afterwards.

This paper is very little known, and I have never seen it quoted, although several previous estimations are corrected therein.

I have often studied and consulted these works on account of the numerous details they furnished me with for my own experiments on the atomic weights of carbon, phosphorus, zinc, tin, and hydrogen.† The verification to which I have submitted the calculations of M. Stas seems superfluous, seeing that it deals with the experiments of a *savant* who has never had an equal in exactitude. It may perhaps astonish some as much as it did me to find that the original memoirs contain numerous arithmetical mistakes as well as typographical errors, of which some are considerable.

In his first published paper M. Stas gives a table of atomic weights, the result of his researches, but he says hardly a word of the method of arriving at them. In the two other memoirs we find further details on that point, but as these books have been written in parts at different times they do not treat the subject in a general manner. Nobody has yet gone over the calculation of the complete system of these estimations, which fact encourages me to publish this essay.

It is part of a long tedious work which comprises all the simple bodies. According to the recent works of MM. Becker, Clarke, Meyer and Seubert, Sebelien and Oswald, the detail and publication of these calculations would be useless. I will therefore only communicate my results, that is to say, the atomic weights which seem to me to be most reasonable, and the uncertainty which still exists about each.

* *Ann. Chim. Phys*, 6th Series, vol. vii., April, 1886.

† A preliminary notice is inserted in the *Comptes Rendus de l'Académie des Sciences*, Jan. 5, 1885, vol. c., pp. 52 and 1175.

Table of Atomic Weights according to M. van der Plaats.

	Atomic weights.	Degree of uncertainty.
Ag	107·93	0·01
Al	27·08	0·05
As	75·0	0·3
Au	196·7	0·5
Ba	137·1	0·1
Bi	208·0	0·3
Bo	11·0	0·1
Br	79·955	0·01
C	12·005	0·005
Ca	40·0	0·05
Cd	112·1	0·2
Ce	141·5	1·0
Cl	35·456	0·005
Co	58·8 or 60·0	0·5
Cr	52·3	0·3
Cs	132·8	0·3
Cu	63·33	0·02
Di	145·0	3·0
Er	166·0	2·0
F	19·0	0·1
Fe	56·0	0·05
Ga	70·0	1·0
Gl	9·1	0·2
H	1·00	0·005
Hg	200·1	0·2
In	113·7	0·5
Ir	193·0	0·2
I	126·86	0·01
K	39·144	0·01
La	138·0	2·0
Li	7·02	0·01
Mg	24·4	0·05
Mn	55·0	0·1
Mo	96	0·3
N	14·05	0·01
Na	23·05	0·005
Nb	94·0	2·0
Ni	58·0 or 58·8	0·5
O	16	Basis.
Os	195	5·0
P	30·95	0·05
Pb	206·91	0·05
Pd	106·5	1·0
Pt	194·9	0·2
Rb	85·4	0·1
Rh	104·0	1·0
Ru	104·0	1·0
S	32·06	0·01
Sb	120·0	0·2
Sc	44·0	0·5
Se	79·0	0·2
Si	28·0	0·1
Sm	150·0	0·5
Sn	118·1	0·1
Sr	87·5	0·1
Ta	182·8	0·5
Te	125·0	3·0
Th	233·0	1·0
Ti	48·1	0·1
Tl	204·2	0·5
U	240·0	1·0
V	51·3	0·1
W	184·0	0·2
Y	89·5	1·0
Yb	173·0	1·0
Zn	65·3	0·1
Zr	90·5	1·0

I must hasten to say that this is the only point on which I could venture to correct or control the work of the illustrious *savant* at Brussels. Having devoted several years to similar researches, I am the more able to appreciate the vast difference which separates the estimations of atomic weights of other chemists from those of M. Stas.

The remarks and corrections which I am about to make are founded entirely on the observations and data given by M. Stas himself.

As we have to deal sometimes with the determination of the third decimal, I have calculated the fourth. As I used logarithms of seven decimals, the seventh figure may be, at the most, one or two units wrong. All my calculations have been done twice and then verified; I hope therefore that they are exact.

(To be continued).

NOTE ON WATER OF CRYSTALLISATION.

By W. W. J. NICOL, M.A., D.Sc.

WHEN a hydrated salt is dissolved does it retain its water of crystallisation, or does this latter cease to be distinguishable from the solvent water? Both views have found advocates among chemists who have looked at the question of solution, and both have been supported by arguments more or less to the point. But among the possible means of solving this question there is one which has entirely escaped the notice of those interested in the subject. And those who hold that water of crystallisation exists in solution have been entirely oblivious of the fact that, while they are ready to accept the results of the modern science of thermo-chemistry and to employ them to support their views on hydration, yet these very results if correct prove without a shadow of a doubt that water of crystallisation does not exist in solution.

The proof is so clear and self-evident when once one's attention is directed to it, that, though I intend to develop it more fully on another occasion, I feel that it is better to publish an outline of it at once.

Thomsen has found that the heat of neutralisation of the soluble bases of the alkalies and alkaline earths with sulphuric acid has a mean value of 31·150 c. within very narrow limits. When hydrochloric or nitric acid is employed the value is 27·640 c., also within very narrow limits. Now this agreement of the six bases in their behaviour with sulphuric acid, much more of the seven bases with both HNO_3 and HCl, is so close that it cannot be regarded as accidental, but, in the words of Meyer, the heat of formation of a salt in aqueous solution is a quantity made up of two parts, one a constant for the base, the other for the acid. But of the 20 salts thus formed some are anhydrous in the solid state, others have water of crystallisation, up to 10 molecules in the case of Na_2SO_4. If water of crystallisation exists in solution it will be necessary to suppose that this agreement is accidental, which is absurd, as a glance at the probabilities will show. Thomsen himself expressly states that he regards the dissolved state as one in which the conditions are comparable for all substances: this would be impossible if water of crystallisation were present.

A still stronger proof is afforded by the "*avidity*" of Thomsen or the "*affinity*" of Ostwald—both have worked on the subject, taking no account of water of crystallisation, and the results, *e.g.*, for H_2SO_4 and HCl with NaHO, where water of crystallisation *may* come in, are entirely confirmed by Ostwald's results on inversion and etherification, where there can be no water of crystallisation.

The proof is complete, water of crystallisation cannot be attached to the salt in solution, or if it is no heat is evolved on union more than with solvent water. The alternative is to suppose that the whole of the above thermo-chemical results are coincidences.

On Dehydromorphine.—Dr. Julius Donath.—Dehydromorphine, tried in quantities of 0·5—1·5 grm., could be reduced to morphine neither by sodium amalgam in an alkaline solution nor by zinc or tin in an acid liquid.

ON RADIANT MATTER SPECTROSCOPY.*

Part II.—Samarium.

By WILLIAM CROOKES, F.R.S

(Continued from p. 43).

Purification of Samaria.

133. The foregoing experiments left little doubt that *x*, the orange-band-forming body, was samarium; the last problem was, therefore, to get this earth in a pure state. The general plan of operations was the same as I adopted in getting didymium free from samarium, only attention was now directed to the portions richest in samarium which had been formerly set aside (128, 129). On fractionation in highly dilute solutions with very weak ammonia the first precipitates are richer in samaria than the last. These first precipitates were re-converted into nitrates, and fractionation again proceeded with.

Fusion of the nitrates with potassic nitrate (129), or precipitation by, and washing with, potassic sulphate (130), are of no use in the final purification of samarium. When the object is to separate a little samarium from a large quantity of didymium, fusing the nitrates will effect the purpose, but I have not found the converse to hold good. The potassic sulphate method cannot separate the last traces of didymium from samarium, for the didymic double sulphate, not being quite insoluble, would wash out along with the first portions of the samaric salt. I have found no method better than fractionation with ammonia, and Prof. Clève tells me that is his experience.

Towards the end of the operations, when the samaria is getting pure, it is useful to precipitate it as a double sulphate with potassic sulphate, and wash it well for some time, to remove any traces of earths of the yttria and other groups which might have been present and become accumulated with the samaria (123).

134. During fractional precipitation with ammonia an experienced eye can judge roughly what is the preponderating earth present, by the appearance of the precipitate as it comes down. When much samaria is present, with but little didymia and lanthana, the precipitate forms immediately. When there is much didymia, and little samaria and lanthana, the precipitate forms almost as quickly as in the first case, but does not settle so rapidly. With much didymia, and a fair quantity of lanthana, the precipitate forms more slowly than before and settles sluggishly. When there is much lanthana and little didymia the precipitate takes a long time to settle, the liquid remaining opalescent for days. These peculiarities are due in great measure to the varying basicity of the elements, samarium being the least basic and lanthanum being the most basic, didymium occupying an intermediate position.

In freeing samarium from the last portions of didymium the only test available to detect the presence of the latter metal is the absorption spectrum. The best plan is to provide a strong solution of the samaric nitrate in a flask, to act as a lens, and to concentrate the light of a gas-flame by its means on to the slit of a low dispersion spectroscope. Long after the light colour of the ignited oxide shows that the didymium is getting small in quantity, its absorption bands will be so strong as almost to obliterate the fainter samarium spectrum.

135. The fractionation should be persevered in till no didymium bands are seen in the absorption spectrum. After this point is reached I prefer to keep on fractionating for some time longer, if the material will hold out, so as to make assurance doubly sure. The colour of samaria, as pure as I have been able to prepare it, is white with the faintest possible tinge of yellow. The absorption spectrum of samarium salts is much more feeble than the spectrum of didymium salts.

The accompanying drawing (Fig. 2) shows the absorption spectra of solutions of didymic and of samaric nitrates. It will be observed that the strongest bands of the samarium absorption spectrum are almost covered by strong absorption bands of didymium. Unless, therefore, the samarium is decidedly in excess, it will be difficult for any but a very practised observer to detect its presence. Fortunately the marvellous delicacy of the phosphorescent

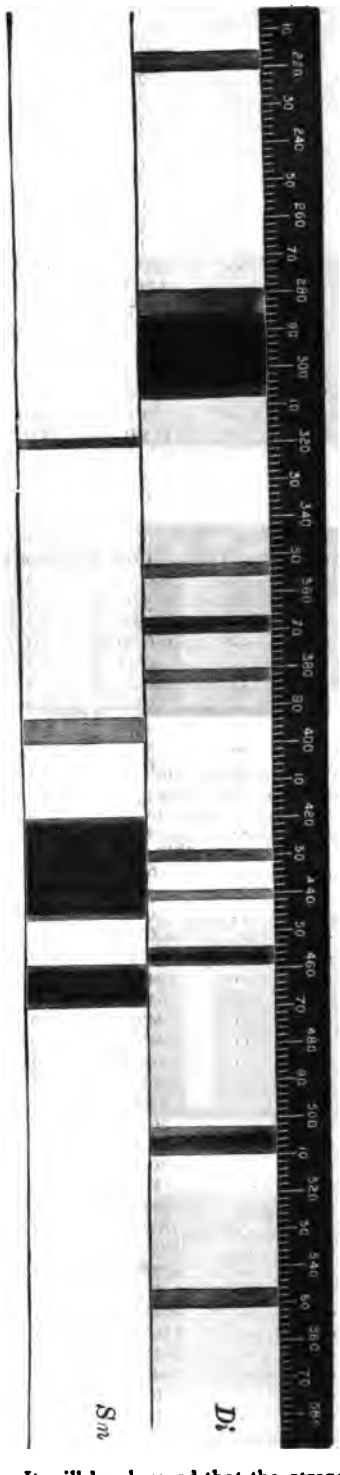


Fig. 2.

* A Paper read before the Royal Society, June 18, 1885.

spectrum of samarium renders any other spectrum test of little value.

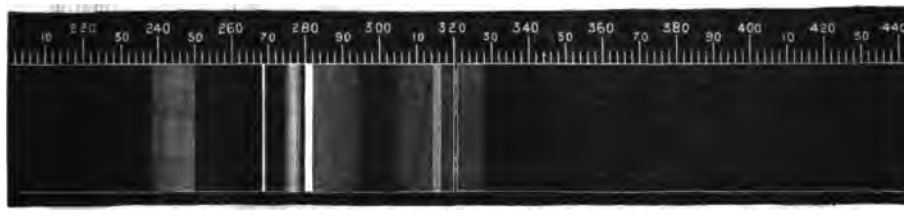
136. I have already mentioned (117) that the cerite earths are supposed to contain a fifth member, which has been provisionally called Yα.* Not much is known respecting the properties of this earth, but from the little I can glean it would appear to become concentrated with the samarium, from which a partial separation may be effected either by continuing the operation of fractional precipitation or by taking advantage of the different solubilities of their double potassic sulphates in potassic sulphate; the potassio-samaric sulphate being almost insoluble in a saturated solution of potassic sulphate, whilst the corresponding salt of Yα is soluble in 100 to 200 volumes of the same solution. By persevering in this mode of treatment I ultimately obtained a small quantity of a white earth which gave no samarium spectrum in the radiant-matter tube. Whether or no it was Yα I cannot say, as the quantity obtained was insufficient to enable me to determine its atomic weight.

The Phosphorescent Spectrum of Samarium.

137. Pure samaric sulphate by itself gives a very feeble spectrum. Some of the pure salt was heated to redness,* sealed in a radiant-matter tube, and carefully exhausted.

FIG. 3.

FIG. 4.



The coil was adjusted so as to give a powerful spark; the room was well darkened, and the eye kept shielded from extraneous light. It was difficult to hit the exact moment of exhaustion between the disappearance of gas and non-conductivity, but by careful watching at the spectroscope a point was reached at which the phosphorescence appeared. The spectrum consists of a faint band in the red, then a sharp orange line (146, 165), next a wide ill-

FIG. 5.

FIG. 6.

* Marignac, *Comptes Rendus*, vol. xc., p. 899; CHEMICAL NEWS, vol. xli., p. 250.

* Samaric sulphate is not decomposed at the temperature employed.

defined orange band, and finally an equally ill-defined green band. The appearance is shown in Fig. 3.

138. When, however, the samaria is mixed with lime (114) before examination in the radiant-matter tube, the change is very striking, and the spectrum is, if anything, more beautiful than that of yttrium. The bands are not so numerous, but the contrasts are sharper. Examined with a somewhat broad slit, and disregarding the fainter bands, which require care to bring them out, the spectrum is seen to consist of three bright bands,—red, orange, and green,—nearly equidistant, the orange being the brightest. With a narrower slit the orange and green bands are seen to be double, and on closer examination faint wings are seen, like shadows to the orange and green bands. In this spectrum the sharp orange-coloured line (137) of pure samaric sulphate is absent.

139. The bands are best seen in a spectroscope of low dispersion, and with not too narrow a slit. In appearance they are more analogous to the absorption bands seen in solutions of didymium than to the lines given by spark spectra. Examined with a high magnifying power all appearance of sharpness generally disappears: the scale measurements given below must therefore be looked upon as approximate only; the centre of each band may be taken as accurately determined within the unavoidable errors of experiment, but it is impossible to define their edges with much precision.

140. The accompanying cut (Fig. 4) gives as good an idea of the spectrum of samarium-calcium as is possible in black and white. The numbers along the top are the squared reciprocals of wave-lengths, and are on the same scale as the diagram of the yttrium spectrum (71) given in my Bakerian Lecture already quoted. The phosphorescing mixture in the tube consisted of 20 parts of pure samaria and 80 parts of lime. They were converted into nitrates in a platinum capsule, and then decomposed by excess of sulphuric acid and ignited at a dull red-heat. If sulphuric acid is added in the first instance there is a difficulty in getting the earths completely converted.

The least refrangible band seen is a very faint red, which extends from $\frac{1}{\lambda^2}$ 2310 to 2400. Here a much stronger red band begins extending to 2494. The first component of the bright orange band begins at 2739 and ends at 2762. Between 2762 and 2798 is a dark interval, and then the second component of the orange band is seen extending from 2798 to 2818. This band is stronger and more sharply defined than the preceding band. A faint yellow wing extends from the second orange band to 2942. There is now an intensely black interval reaching to 3025; here a faint yellowish green light is seen extending to 3149, where the green band commences and extends to 3164. Here a fainter green wing begins, and extends to 3270. On this wing a very narrow faint green band is seen, having its centre at 3190. There is then another dark space, after which three ill-defined blue and violet bands are seen, too faint to measure accurately.

141. Preliminary experiments (114) had shown me that lime was one of the best materials to mix with samaria in order to bring out its phosphorescent spectrum, but it was by no means the only body which would have the desired effect. More accurate observations were now taken with pure materials mixed together in definite quantities. The bodies employed were those enumerated in par. 113. Of these the following induced no phosphorescence:—zirconium, cerium, didymium, copper, silver, manganese, and tin; silicic, titanic, tungstic, molybdic, niobic, and tantalic acids.

142. The other substances which I tried caused the samarium to give good phosphorescence with a discontinuous spectrum. There is a general resemblance between these spectra, but nearly all of them differ one from another in details. In the following descriptions I will take the calcium-samarium spectrum (140) as the standard of comparison:—

Strontium and barium, when mixed with samarium, give almost identical spectra; the red band is similar to the one produced by calcium, but the orange bands have become a blurred orange space, with outline ill-defined on the side towards the red, and sharper at the more refrangible side. There is no trace of division in the orange space; but the green, which with calcium is narrow and single, becomes with barium and strontium a well-defined luminous double green band, with a sharp black separating interval.

Beryllium and samarium give a very faint phosphorescent spectrum, consisting of a red, orange, and green band only; the green occupying the position of the second green band given by calcium-samarium.

143. Thorium and samarium give a very similar spectrum to the one produced by barium or strontium with samarium, a slight difference being observable in the orange, which shows signs of separation into two components.

Thorium, as oxide or sulphate, by itself gives no phosphorescence (26, 28), and in fact, as I have already shown, renders the vacuum tube non-conducting;* samaria likewise gives scarcely any phosphorescence (137). It is, therefore, somewhat remarkable that a mixture of these two bodies should bring out the samarium spectrum so brilliantly.

Magnesium and samarium give the red band and second orange band sharply; the first orange is, however, obliterated, and its place occupied by a faint, broad, ill-defined band, extending to the orange band. The green band is very wide, faint, and ill-defined.

Zinc and samarium give the red band as usual, but there is only one orange band, which is sharp, and occupies the position of the interval between these bands in the calcium and samarium spectrum. The green band is widened out, and occupies the position of the second green band of the thorium-samarium spectrum.

The cadmium-samarium spectrum is similar to that of zinc-samarium, only the green band is still wider, and extends further towards the red end.

144. Lead with samarium gives a very brilliant spectrum. The red is clear and sharp, and has a narrow faint wing on each side. The orange is one wide band, with no trace of division, whilst the green is sharp and duplicated as in the thorium-samarium spectrum, to which, indeed, it bears a great resemblance. The centres of the green bands are at $\frac{1}{\lambda^2}$ 3133 and 3199.

Lanthanum and samarium phosphoresce brightly, and give a very sharp spectrum consisting of three bands, closely resembling the zinc-samarium spectrum; the red, however, not being so bright as the other two bands. On the contrary, cerium or didymium mixed with samarium gives no phosphorescence.

Aluminium and samarium give a spectrum resembling the corresponding calcium one as to the red and double orange, but having a very broad, somewhat faint, green band, with a black division in the middle occupying the position of the bright green band of calcium-samarium.

Bismuth and samarium gave a somewhat faint spectrum, almost identical with the lanthanum-, zinc-, cadmium-, and glucinum-samarium spectrum.

The antimony-samarium spectrum is almost identical with that with bismuth, the spectrum being, however, much fainter.

145. The samarium spectra, modified by other metals as above described, may be divided into three groups. The

* "This earth is, however, remarkable for its very strong attraction for the residual gas in the vacuum tube. On putting thorina in a tube furnished with well-insulated poles, whose ends are about a millimetre apart in the centre, and heating strongly during exhaustion, the earth, on cooling, absorbs the residual gas with such avidity that the tube becomes non-conducting, the spark preferring to pass several inches in air rather than strike across the space of a millimetre separating the two poles."—*Proc. Roy. Soc.*, No. 213, 1881, vol. xxxii., p. 209.

first group comprises the spectra given when glucinum, magnesium, zinc, cadmium, lanthanum, bismuth, or antimony is mixed with the samarium. It consists simply of three coloured bands, red, orange, and green; as a typical illustration I will select the lanthanum-samarium spectrum (Fig. 5). The centres of the bands are—red 2429, orange 2808, and green 3177.

The second type of spectrum gives a single red and orange and a double green band. This is produced when barium, strontium, thorium, or lead are mixed with samarium. The lead-samarium spectrum (Fig. 6) illustrates this type. The centres of the bands of this spectrum are—red 2437, orange 2830, green 3133 and 3199.

The third kind of spectrum is given by calcium mixed with samarium. Here the red and green are single, and the orange double. Aluminium would also fall into this class were it not that the broad ill-defined green band is also doubled. The calcium-samarium spectrum, already illustrated in Fig. 4 (140) is a good illustration of this type.

(To be continued.)

ON THE SO-CALLED SILVER SUB-CHLORIDE.

By SPENCER B. NEWBURY.

A YEAR ago I published a series of experiments* on the action of solvents on silver chloride which had been blackened by exposure to light, from which the conclusion was drawn that in the blackening action of light no silver sub-chloride, but only metallic silver, is formed. This was shown to be the case by the fact that if blackened silver chloride be treated repeatedly with a concentrated solution of sodium chloride, the silver chloride which has escaped reduction is completely dissolved, and pure, finely divided metallic silver remains.

The existence of silver sub-chloride has generally been assumed by chemists and writers on photography, and the formula Ag_2Cl has been supposed to represent its composition. A very complete outline of the literature of the subject is given by Von Bibra,† and need not be repeated here. There may be said to be three methods by which the so-called silver sub-chloride has been prepared, as follows:—

1. Cavillier,‡ by passing excess of chlorine into an ammoniacal solution of silver chloride.
2. Wetzlar,§ by action of iron or copper chloride on metallic silver.
3. Wöhler,‖ by the action of hydrochloric acid on silver sub-oxide or its salts.

In the last case Wöhler prepared silver sub-citrate by heating silver citrate to 100° in a current of hydrogen: he expressly states, however, that the existence of this substance is not proved, since a mixture of metallic silver with undecomposed citrate would behave in a similar manner. By treatment of the sub-chloride with potash and hydrochloric acid respectively, Wöhler obtained the corresponding silver sub-oxide and sub-chloride. No attempts seem to have been made to free these substances from possible admixtures of metallic silver or from unchanged citrate or chloride, in order to render the analysis of them conclusive. Von Bibra¶ prepared the so-called sub-chloride by the three methods given above, and concluded that No. 1 gives true sub-chloride; No. 2, a mixture of silver and silver chloride; No. 3, also true sub-chloride. In the last case Von Bibra assumed the reaction to be complete when the weight of the silver citrate, after heating six to seven hours in a current of hydrogen, remained constant; washed the product with water to remove free citric acid, treated with HCl, assumed the product to be pure silver sub-chloride, and established its formula to be Ag_4Cl_2.

In the hope of preparing the sub-chloride in a pure state by the action of some solvent which should remove possible impurities, I was led to make the following experiments:—

1. The method of Cavillier, by action of chlorine on ammoniacal silver solutions, was tested. A stream of dry chlorine was conducted into a solution of silver chloride in ammonia. A slight grey precipitate was gradually formed, which, if the solution was kept strongly ammoniacal, consisted of finely divided silver wholly soluble in nitric acid. If, however, the ammoniacal solution was allowed to become nearly saturated with chlorine, mixtures of silver chloride and metallic silver, in varying proportions, were deposited, which on treatment with NaCl left a residue of grey metallic silver. From this I conclude that no sub-chloride is formed by this reaction. This is not remarkable, since all authorities agree that the hypothetical sub-chloride is decomposed by ammonia, silver chloride being dissolved, and metallic silver remaining. The formation of the sub-chloride in a strongly ammoniacal solution was therefore not to be expected. The precipitation of a small quantity of metallic silver is perhaps owing to impurities in the chlorine which exercise a reducing action.

2. Finely divided silver was treated with a cold 20 per cent solution of cupric chloride. Cuprous chloride was at once formed, but re-dissolved on addition of large excess of cupric chloride solution, leaving only white silver chloride.

If a few drops of stannous chloride solution are added to a solution of silver nitrate, a precipitate is formed which is at first white, but becomes black on stirrring. Analysis of this precipitate showed silver and chlorine in varying proportions. If, however, stannous chloride be added in excess, a white precipitate consisting of silver chloride and a tin compound, probably oxychloride, is formed. If, therefore, dilute silver nitrate solution be gradually added to dilute stannous chloride solution until a dark precipitate begins to form, the precipitate then filtered off, and a further addition of silver nitrate made to the filtrate, a black precipitate is obtained. This was found to be metallic silver. It is evident that it is the stannous nitrate formed in this reaction which reduces the silver after all the chlorine has been precipitated, and also that no silver sub-chloride is formed.

3. I have made a large number of careful experiments on the preparation of silver sub-citrate by heating silver citrate to 100° in a current of hyrdogen, following exactly the instructions of Wöhler and Von Bibra. The hydrogen was passed through a red-hot tube, and dried with sulphuric acid and calcium chloride. The silver citrate was very carefully dried in vacuum. Nevertheless I did not find it impossible to obtain a constant weight as described by Von Bibra, nor to obtain a product of definite composition. Water was always given off, and a gradual decrease in weight took place, more or less rapid according to the rapidity of the stream of hydrogen. The silver citrate was changed to a black powder, under the action of a moderate current of gas, in about two hours, and was then found to have lost about 2 per cent of its weight. If the action was continued several hours longer the mass appeared to be partly fused, had a metallic lustre, and was found in some cases to have lost weight to the amount of 6 per cent. On treating the product with water a solution resulted which was red by transmitted light, but invariably grey and cloudy by reflected light. It seems to me highly probable that this red colour is caused by finely divided metallic silver. Hydrochloric acid produces in the solution a reddish precipitate, which on analysis was found to consist of silver chloride, with a minute amount of free silver. This shows that even when the

* *American Chemical Journal*, vol. vi., No. 6.
† *Journ. f. Prakt. Chem.*, 1875.
‡ *Journ. d. Pharm.*, 1830.
§ *Jahresber.*, 1828.
‖ *Ann. Chem. Pharm.*, xxx.
¶ *Loc. cit.*

action of the hydrogen is continued for several hours there is still a large amount of unchanged citrate present. I have made many attempts to separate the constituents of this black substance by solution in water, but obtained no results, because the red solutions are not clear, and give only silver chloride and traces of silver on treatment with HCl. It is evident that the statement generally contained in the text-books, that the argentous citrate dissolves in water with a red colour, is incorrect.

On treating the black powder directly with hydrochloric acid, curdy brown precipitates were obtained, which contained varying proportions of silver and silver chloride, according to the duration of the action of the hydrogen. The substances were analysed by dissolving out the silver chloride by ammonia, and weighing residue of metallic silver. The formula Ag_4Cl_3 requires AgCl 81·8 per cent, Ag 18·2 per cent; Ag_2Cl requires AgCl 57·1 per cent, Ag 42·9 per cent. Varying proportions of silver were found, according to the length of time treated. In some cases the amount of silver was found to exceed 60 per cent.

The substances obtained by acting upon the reduced citrate with hydrochloric acid were treated with cold solution of sodium chloride. In every case silver chloride was dissolved, and a residue of metallic silver was left. Wöhler, in the article referred to above, states that ammonium chloride solution produces this result. It is therefore evident that if the sub-chloride exists it is of so unstable a character as to be readily decomposed by the ordinary solvents of silver chloride. There is, in fact, no evidence whatever of the existence of such a compound, or that the substances which have been supposed to be silver sub-chloride are anything but simple mixtures of silver and silver chloride.

In the case of the sub-citrate and sub-oxide the fact that Wöhler and Von Bibra obtained a product of constant weight on heating silver citrate in hydrogen has been assumed to be a proof of the existence of these substances. However, the hypothesis of the formation of silver sub-citrate does not account for the *loss* of weight which has been in every case observed. The replacement of silver by hydrogen, and setting free of citric acid, calls for a gain in weight.

In my own experiments, which have been very numerous, and performed under a variety of conditions, an absolutely constant weight was in no case obtained. Both water and carbon dioxide were given off, in approximately equal quantities, as long as the action of the hydrogen was continued. On exhausting the products with ether a brown tar-like mass was obtained, which contained free citric acid in considerable quantity, together with other substances which were not identified.

In conclusion, the loss of weight on heating silver citrate in a current of hydrogen, the formation of carbon dioxide, and residue of metallic silver left on treating the products with sodium chloride solution, seem to me to indicate that the reaction in question consists in the separation of silver and decomposition of citric acid, rather than in the formation of silver sub-citrate.—*American Chemical Journal*, Vol. viii., No. 3.

Poisoning by Aniline at Bâle. — M. Bruhat. — In France iron filings and acetic acid are generally employed for producing the hydrogen required for the reduction of nitro-benzol to aniline. In Sott Bâle a well-known firm had been using hydrochloric acid instead of acetic acid, and had obtained a quantity of hydrochloric acid from Giessen, said to have been made with strongly arsenical sulphuric acid. The arsenic chloride present was converted in the process into arsenic hydride. The lives of five of the workmen were saved with great difficulty. The question is raised whether coal-tar colours may not be rendered poisonous in this manner, though no arsenic acid has been knowingly used in their manufacture.—*Journ. de Pharm.*

COHESION AND COHESION FIGURES.*

By WILLIAM ACKROYD, F.I.C.

1. *A Law of Solubility.*

It is customary to regard cohesion as the force which binds together molecules of the same substance, and in virtue of which the particles of solids and liquids are kept together, and also to speak of the attraction exerted between particles of two different bodies as adhesion. The distinction between cohesion and adhesion is a conventional one. The similarity, if not identity, of the two forces is demonstrated by the fact that while cohesion is exerted between particles of the *same* body, adhesion is exerted with most force between particles of *allied* bodies. Generally speaking, organic bodies require organic solvents; inorganic bodies, inorganic solvents. For example, common salt is highly soluble in water but not in ether, and many fats are soluble in ether but not in water. So many cases like these will suggest themselves to the chemist that I am justified in making the following generalisation:—*A body will dissolve in a solvent to which it is allied more readily than in one to which it is highly dissimilar.* Exceptions to the law undoubtedly exist, but none so striking as the following in support of it, viz., that the metal mercury is the only known true solvent for many metals at the normal temperature.

2. *Its Connection with Mendeleeff's Periodic Law.*

From this standpoint the whole subject of solution is deserving of fresh attention, as it appears highly probable that, just as Prof. Carnelley has shown, by the use of my meta-chromatic scale that the colours of chemical compounds come under definite laws, which he has discovered and formulated in connection with Mendeleeff and Newland's periodic law,† so, likewise, may the solubility of an allied group of compounds, in regard to any given solvent under constant conditions of temperature, conform to similar laws; that, *e.g.*, the chlorides of H, Na, Cu, and Ag in Mendeleeff's Group I. may vary in their solubility in water from an extreme of high solubility in the case of hydrogen chloride to the opposite extreme of comparative insolubility in the case of silver chloride. In this natural series of compounds hydrogen chloride is the body nearest akin to water, and silver chloride the most remote in kinship.

3. *A Solidified Vortex Ring.*

It is in virtue of cohesion that a freely suspended drop of liquid assumes the spherical form. If such a sphere be dropped on to the surface of a liquid of higher specific gravity at rest, one obtains what is called the cohesion figure of the substance of the drop. A drop of oil, *e.g.*, spreads out on the surface of water until it is a circular thin film of concentric rings of different degrees of thickness, each displaying the characteristic colours of thin plates. The tenuity of the film increases; its cohesion is overcome; lakelets are formed and they merge into each other. The disintegrated portions of the film now thicken, the colours vanish, and only islets of oil remain. Some liquid drops of the same or higher sp. gr. than water do not spread out in this fashion but descend below the surface of the liquid, and, in descending, assume a ring shape which gradually spreads out and breaks up into lesser rings. Such figures have been termed submergence cohesion figures; they are vortex rings. I have solidified such vortex rings in their first stage of formation. If drops of melted sulphur at a temperature above that of the viscous state be let fall into water the drops will be solidified in the effort to form the ring, and the circular button, thick in the rim and thin in the centre, may be regarded as a solidified vortex ring of plastic sulphur.

* Notes from a Lecture given to the Halifax Scientific Society, July 19, 1886.

† *Philosophical Magazine*, August, 1884.

4. That a Submergence Cohesion Figure is a Vortex Ring.

It may be shown that the conditions of the formation of a submergence cohesion figure are those which exist in the formation of an aërial vortex. Those conditions in their greatest perfection are (1) a spherical envelope of a different nature from the medium in which the rings are produced, (2) a circular orifice opening into the medium, and (3) a percussive impact on the part of the sphere opposite the orifice. In the production of vortex rings of phosphorus pentoxide in the making of phosphoretted hydrogen, the spherical envelope is water, the orifice the portion of the bubble which opens into the air immediately it rises to the surface, and the impact is furnished by gravity. So, also, in the case of a submergence cohesion figure, the spherical envelope is the air surrounding the drop, the orifice the portion of it which first comes in contact with the liquid at rest, and here again the impact is due to gravity more directly than in the former case. These conditions are somewhat imperfectly copied in the ordinary vortex box, which is usually cubical in form, with a circular orifice in one side and a covering of canvas on the opposite one, which is hit with the fist.

ON DINITROSULPHOCYANBENZENE.*

By PETER T. AUSTEN and FRANKLIN S. SMITH.

CLEMM† found that when trinitrochlorbenzene was treated with potassium sulphocyanide an energetic action ensued and a well-characterised compound was formed. He was unable, however, even after a number of analyses, to assign any satisfactory formula to this substance.

It appeared probable that the dinitro-derivitative would be less likely to cause the formation of secondary reactions, and, if this were the case, a dinitrosulphocyanbenzene would be created. It was found on experiment that the reaction did take place easily and in quite quantitative relations.

Dinitrobrombenzene was dissolved in methyl alcohol, and about half its weight of potassium sulphocyanide added. The flask was placed on a water-bath and connected with a return condenser. After boiling a short time the precipitation of a yellow, crystalline sand begins, the amount of which continually increases. To avoid the excessive bumping which soon takes place, it is well, at intervals, to pour off the liquid, remove the sand, and begin the boiling anew. After an hour's boiling but little more precipitation takes place. The sand should then be removed and the liquid distilled down about one-half. On boiling the remaining liquid as before, a fresh deposit of sand will take place. In this manner a very satisfactory yield is obtained. The liquid shows a strong reaction for bromides as soon as this precipitation of the sand begins.

Dinitrosulphocyanbenzene.

The yellow sand obtained by the method just described was well washed with boiling methyl alcohol to remove any traces of the dinitrobrombenzene, and then repeatedly boiled out with water until free from bromides. When dry the substance is a fine sand, which consists of yellow, crystalline, transparent grains. It is moderately soluble in boiling chloroform, which is the best solvent which we have yet been able to find for it. Crystallised from chloroform it forms buff-yellow, small, hard, transparent crystals fusing at 139°.

Analysis:—

$C_6H_3(NO_2)_2SCN$.	Calculated.	I.	II.
C	37·33	37·12	37·43
H	1·33	1·51	1·37
N	18·66	18·24	18·06
S	14·22	14·43	—

The substance is reduced with difficulty by tin and hydrochloric acid. The resulting base was not examined. The substance was slowly dissolved by concentrated boiling caustic soda, but no definite compound could be isolated from the resulting solution.

Dinitrophenylmercaptan.

When dinitrosulphocyanbenzene is added to an excess of concentrated sulphuric acid and the mixture gently heated, the reaction begins and the temperature rises, while large amounts of sulphur dioxide and carbon dioxide are evolved, and ammonium sulphate is formed in the solution. The substance, which at first goes into solution in the acid, is re-precipitated. The resulting liquid and precipitate were allowed to cool somewhat and then poured carefully into a sufficient volume of cold water. The precipitate was filtered off and washed with hot water till no reaction for sulphuric acid was obtainable.

As we were unable to find any solvent for this substance from which we could crystallise it (even nitrobenzene failing to give satisfactory results), we proceeded to purify by repeated extractions with boiling alcohol, and lastly with boiling chloroform. The compound obtained after drying is an impalpable, light yellow powder. It is extremely adherent to glass, which makes it rather difficult to transfer it from one vessel to another, and it is also not easy to obtain it perfectly free from moisture.

$C_6H_3(NO_2)_2SH$.	Calculated.		
C	36	35·50	35·50
H	2	2·66	2·17
N	14	14·40	—
S	16	15·57	—

The substance is insoluble in the usual solvents. Nitrobenzene dissolves small amounts of it, but we were unable to obtain it again in a crystalline condition. It dissolves easily in warm, concentrated nitric acid, and is precipitated unchanged on pouring the solution into cold water. It fuses at 195°, and on heating it deflagrates.

We were somewhat at a loss at first to understand the reaction taking place here, but on comparing it with the action of concentrated hydrochloric acid under pressure on sulphocyanbenzene,* the mechanism of it was at once apparent.

$$C_6H_5SCN + 2H_2O = C_6H_5SH + CO_2 + NH_3,$$
$$C_6H_3(NO_2)_2SCN + 2H_2O = C_6H_3(NO_2)_2SH + CO_2 + NH_3.$$

The evolution of sulphur dioxide is probably due to a secondary action. If the action is continued too long, or the heat is raised too high, the substance is decomposed, and the compound is not obtained.

Dinitrophenylsulphide.

When dinitrosulphocyanbenzene is added to a mixture of fuming nitric acid and concentrated sulphuric acid, and the whole warmed, an energetic action takes place. The resulting solution was poured into water, and the white, flocculent precipitate which separated was washed out with boiling water and dried. It formed a grayish-white mass with a very irregular fracture. It dissolved in boiling glacial acetic acid with some difficulty, but more easily when it was well rubbed with the acid in a mortar so as to remove the adhering film of air. From this solution it crystallised in beautiful transparent, slightly yellow needles nearly a quarter of an inch long and about as thick as a pin, forming fan and stellar aggregates and fusing at 245°.

Analysis gave—

$(C_6H_3(NO_2)_2)_2S$.	Calculated.	Found.
C	39·34	39·20
H	1·64	1·57
N	15·30	15·38
S	8·74	8·82

* A communication from the Chemical Laboratory of Rutgers College.

† *Journ. Prakt Chem.* 2, 1, 145.

* *Billeter. Ber.*, vii., 1753.

The substance is then dinitrophenylsulphide—

$$\begin{matrix} C_6H_3(NO_2)_2 \\ C_6H_3(NO_2)_2 \end{matrix} \Big\rangle S,$$

and is hence isomeric with the one discovered by Beilstein and Kurbatow.*

CORRESPONDENCE.

DIFFERENTIAL RESISTANCE THERMOMETER.

To the Editor of the Chemical News.

Sir,—The sensibility of the instrument described by Mr. Mendenhall in your issue of June 18th (Chem. News, vol. liii., p. 293) would be more than doubled by stretching two wires from top to bulb of thermometer tube, so that the current passed down one wire, through the mercury to the other wire, and so to the top again. Equation (1) in Mr. Mendenhall's paper would then become—

$$R_t = R_0 - 2st(1+kt).$$

Such a thermometer in connection with a simple form of Wheatstone bridge may be made to read off the temperature direct by once for all obtaining balances at known temperatures, and so dividing the bridge wire into temperature degrees. Again, a simple form of ohm-meter could be used with its scale divided in the way I have indicated. No adjustments whatever would then be necessary before taking readings; in fact, if the battery were always on, a continuous record could easily be obtained.—I am, &c.,

Sydney Evershed.

Kenley, Surrey, July 26, 1886.

THE GAS ENGINEERS' CHEMICAL MANUAL.

To the Editor of the Chemical News.

Sir,—In handing you my just-issued book, which bears the above title, I hope you will allow me to make a short statement in your influential journal, the Chemical News.

My book consists of seven chapters. Chapter I., the Introductory, shows the great extent of the Gas Industry in this country, viz., that about £70,000,000 is embarked in it as its capital, and gives a sketch of the operations performed in gasworks. Chapter II. is on Coal. Chapter III. is devoted to Gas. At the end of the chapters there is a short table of the weights of 100 cubic feet of some of the commonest gases. The table has been calculated by myself, and is, I believe, more accurate than any other table of these weights which has hitherto been published. The same chapter contains an account of my system of gas-analysis, which, according to the remark in the preface, "has claims to be considered as being, in some subordinate sense, new and original."

Tar, Gas-liquor, Coke, and lastly, Purification of Gas, have each of them a chapter specially assigned to them.

Faults and omissions the book has—the author will doubtless hear of them in due time from his readers and his reviewers.—I am, &c.,

J. Alfred Wanklyn.

July 27, 1886.

On a Crystalline Potassium Alcoholate.—R. Engel.—The author has obtained a compound which he names potassium alcoholate. The same name has been applied to compounds of alcohols and bases in which the metal is substituted for the hydrogen of the alcohol. To avoid confusion he therefore proposes to reserve for these latter bodies the names of methylates, ethylates, &c.—*Comptes Rendus*, vol. ciii., No. 2.

* *Ann. d. chem. u. Pharm.* 197, 77.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 2, July 12, 1886.

Identity of Origin of the Fluorescence $Z\beta$ on Reversal and of the Bands obtained in a Vacuum.—Lecoq de Boisbaudran.

Formation-Heat of Hydroselenic Acid.—Ch. Farre.—The formation-heat of gaseous hydroselenic acid, setting out from gaseous hydrogen and amorphous selenium, is −9·44 cals.

New Species of Asparagine.—A. Piutti.—The rotatory power of this new asparagine is equal to that of the normal variety, but of an opposite sign. The chemical properties of the two compounds and of their respective derivatives are identical.

Division of a Base between Two Acids: Particular Case of Alkaline Chromates.—P. Sabatier.—Chromic acid behaves with the alkaline bases like a bibasic acid having two distinct functions. As regards potassa the first function of chromic acid, that which yields bichromate, is surpassed only by the first function of sulphuric acid, which yields potassium bichromate. It is very near that of hydrochloric acid, and is certainly superior to the carbonic, acetic, and even phosphoric acids. Hence potassium bichromate undergoes no notable decomposition except with sulphuric acid, which, moreover, does not occasion any change of colour in the liquid. Potassium bichromate, which retains the second function of the chromic acid and forms neutral chromate, ranks below hydrochloric acid, potassium bisulphate, acetic acid, and the first function of phosphoric and carbonic acids. But it appears to be an acid stronger than potassium bicarbonate and the third function of phosphoric acid. The action of powerful acids upon neutral potassium chromate tends to the total displacement of the bichromate in favour of the new acid.

Crystalline Barium and Strontium Titanates.—L. Bourgeois.—The author has studied the crystalline earthy alkaline titanates by fusing the elements of the salt in the corresponding chloride. The crystals of the barium compound have the sp. gr. 5·91, and their composition is $2BaO,3TiO_2$. The strontium compound has the sp. gr. 5·1, and its composition is similar to the foregoing. The calcium compound is identical with perofskite, CaO,TiO_2.

Action of Chlorine upon Potassium Selenocyanide.—A. Verneuil.—The action of chlorine upon the alkaline selenocyanides is quite different from that which it exerts upon the corresponding sulphocyanides.

Transformation of the Glucoses into Dextrines.—E. Grimaux and L. Lefèvre.—The authors effect this transformation by means of dilute hydrochloric acid. The dextrine obtained belongs to the group of the achrodextrines and is not coloured by iodine. The dextrines which have been isolated by various chemists (achrodextrines α, β, &c.) cannot be regarded as distinct chemical species, but as mixtures which it is not possible to separate.

Electrolysis of an Ammoniacal Solution with Electrodes of Carbon.—A. Millot.—This paper will be inserted in full.

On Propionic acid.—Ad. Renard.—Propionic acid occurs in considerable proportions in the tars resulting from the destructive distillation of resin at the temperature of bright redness. Propionic acid boils at 141·5° to 142°. Its sp. gr. at 0° = 1·0089; at +18° = 0·9904. It remains liquid if cooled to −50°. It dissolves in all pro-

portions in water, alcohol, ether, benzol, and petroleum essences.

Conversion of Amides into Amines.—H. Baubigny.—The author described the transformation of amides into amines (by heating with an alcohol in a closed vessel) in a sealed paper deposited with the Academy in 1880, opened in 1882, and published the same year in the *Comptes Rendus* (vol. xcv., p. 646). He expresses his surprise that R. Seifert should have published this conversion as a new reaction (*Berichte Deutsch. Chem. Gesellsch.*, xviii., p. 1355).

Isomerism of the Camphols and Camphors.—Alb. Haller.—On comparing the properties of valerianic camphol and its derivatives with those of the camphol of N'gai and its corresponding derivatives we conclude that the two products are completely identical. Their camphor is also identical with that of mother-wort (*Matricaria*).

Researches on the Development of the Sugar-Beet.—Aimé Girard.—Not suitable for abstraction.

Moniteur Scientifique, Quesneville.
3rd Series, Vol. xvi., July, 1886.

Manufacture of Toilet Soaps.—Dr. C. R. Alder Wright.—From the *Journal of the Society of Arts.*

Manufacture of Leather in Russia.—M. Ryloff.—From this extensive paper it appears that the matters chiefly used in tanning are the bark of the oak containing from 6·04 to 4·37 per cent of tannin according to the season, that of willows, of the elm, and the birch. The leaves of the arbutus, employed in the governments of Kasan, Viatka, and Perm, contain about 16 per cent of tannin, while the root of wild sorrel (*Rumex acetosella*) contains 12 per cent. For removing the hair from hides a lye made from wood-ashes is still employed. The softening of the leather is effected by means of the excrement of dogs, which acts on the leather by means of the biliary acid present, which forms with soda a kind of soap. After tanning white Russia leather is coated with a mixture of tar and of seal oil. Black Russia leather is dyed with alum, extract of sanders, and ferrous sulphate. Horse-hides are tanned to a great extent for sole-leather.

Analysis of Fertilising Matters known as Commercial Manures.—Report of the Second Annual Meeting of Official Agricultural Chemists at Washington. Translated from CHEMICAL NEWS.

Memoir on the Molecular Volumes of Liquids (being a Critique on a Memoir by MM. Bartoli and Stracciati, published in the *Annales de Chimie et de Physique*, March, 1886).—Hermann Kopp.—This memoir is, from its nature and extent, insusceptible of useful abstraction. A preliminary correspondence is appended explaining why it has not been published in the *Annales de Chimie et de Physique.*

Properties and Proprietors of Ungreenable Aniline Black.—This correspondence consists of a reply to M. Grawitz by M. Camille Kœchlin and of a letter on the same side by D. d'Andiran Kœchlin.

Salicylic Acid.—The brewers of Central and Southern France are protesting against the prohibition of the use of salicylic acid as preservative of beer, which, they urge, places them at a disadvantage as compared with their foreign rivals.

Artificial Colouring-Matters applied in Industry.—Dr. E. Noelting.—In this sixth and last lecture Dr. Noelting reviews the saffranines, the indophenols, the indulines, methylene blue, &c.

Industrial Society of Mulhouse.—Session of the Chemical Committee, May 12, 1886.

M. Bourcart remarked that he had repeatedly tried the method of Lux (*Moniteur Scientifique*, Jan., 1886) for detecting small quantities of fatty oils in mineral oils, and that it had given excellent results. The method consists in heating the oil in question with a little sodium or caustic soda. If it contains 1 to 2 per cent of fatty oil it thickens and becomes gelatinous on cooling. A pure mineral oil similarly treated remains unaltered.

M. Camille Kœchlin proposes three new prizes, the last taking the place of No. VII., which has been withdrawn.

1. Medal of honour for a process for preparing cotton with albumen without rendering it harsh. This preparation is to serve as a mordant for dyes which cannot be fixed by means of metallic preparations.

The similarity of the tinctorial properties of wool and of albumen seems to render the solution of this important problem practicable.

2. Medal of honour for a steam albumen orange, of the tone, the intensity, and the fastness of orange minium, easy to print, and not affected by steaming.

3. Medal of honour for an investigation of the colouring-matters fixed respectively by: *a*, the intervention of metallic mordants; *b*, by fatty mordants; *c*, by means of other colouring-matters; and *d*, those which dye without any intermediary.

The Assay of Quinine.—Dr. J. E. de Vry.—From the *Chemist and Druggist.*

On Quinine Hydrate.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Kolbe's Synthesis of Salicylic Acid.—R. Schmitt.—From the *Journal für Praktische Chemie.*

Coloured Reactions of the Phenols with the Carbohydrates.—Anton Ihl.—From the CHEMICAL NEWS.

Determination of Ferric Oxide and Alumina in Phosphates.—Bernard Dyer.—From the CHEMICAL NEWS.

Determination of Glycerin.—W. Fox and J. A. Wanklyn.—From the CHEMICAL NEWS.

Glucose and the Glucasic Saccharification of Amylaceous Matters.—Leon Cuisinier.—The author admits the pre-existence of the glucogenous ferment or *glucase* in grains before germination, as also the production of a liquefying diastase, *maltase*, by germination.

Chemical Patents obtained in France.—A list of the titles of patents for February.

Bulletin de la Société Chimique de Paris.
Vol. xlvi., No. 1, July 5, 1886.

Certain Approximations between Chemistry and Physics.—A. Colson.—The author concludes that for isomers of position the product of the density by the specific heat is constant. Further, isomeric bodies possess the same coefficient of expansion under a constant pressure. From these two propositions there follows a consequence. M. J. Moutier has established that for bodies possessing the same coefficient of expansion under a constant pressure and at a constant volume the product of the specific heat by the density will be constant. By applying this proposition reciprocally we conclude that isomers of position possess the same coefficient of expansion at a constant volume. On studying the relation between the physical constants and the formation-heat, the author finds that of two isomers of position the more dense is formed with the greater quantity of heat. As the product of the specific heat by the density is the same for two isomers, it results that the compound whose specific heat is the smaller is formed with the greater quantity of heat. These propositions are not sufficient to enable us to calculate the difference between the formation-heat of two isomers of position. Such, indeed, is not the object in view. The author wishes to sketch a rational plan which the experimentalist may follow in the preparation of isomers. The quantity of heat liberated being an approximate measure of chemical affinity, and the mass reacting being identical, then if one and the same reaction produces several isomers the maximum effect will be

produced by the most intense affinity. In this case affinity seems to act upon the yield as in hydraulics the difference of level acts upon the flow.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xv., Part 3.

Preservation of Farm-Yard Manure.—Prof. Holdefleiss.—A former result is confirmed, *i.e.*, that manure prepared with potash salts acts less rapidly than that preserved with earth but retains its efficacy longer. The proportion of starch in potatoes is, however, reduced by the former.

Action of Kainit as a Manure at Walna.—Pirscher.—Not only moorlands but sour humous sandy soils can be made to yield remunerative crops by teatment with kainit.

Manurial Experiments with Phosphates in the District of Hanover.—F. Brügmann.—A mixture of Gilchrist and Thomas slag with kainite was found to be the most remunerative application.

Manurial Experiments on Potatoes.—Schrewe.—The application of large quantities of soda-saltpetre with and without phosphates proved remunerative.

Feeding Experiments on Sheep with Raw Sugar.—Prof. Werner,—The author finds that neither raw sugar nor sugar-beets give as good results as bruised corn and mangolds.

Feeding Experiments on Cows with Reference to the Yield of Milk.—Dried brewer's grains were found equal in effect to rape cake, earth-nut meal, &c.

Researches on the Transformation of Matter in Swine.—F. Strohmer, Dr. N. v. Lorenz, and Dr. E. Meissl.—This paper does not admit of useful abstraction.

Cultivation of Grain on the Experimental Field at Grignon in 1884.—P. P. Dehérain.—Already noticed.

Cultivation Experiments with Swedish Grain.—Prof. Leydhecker, A. Müller, and G. Duchman.—Experiments undertaken apparently with a view to ascertain the use of seeds from a more severe climate.

Nutritive Value of Different Portions of the Grain of Wheat.—Aimé Girard.—The author shows that the advantage derived from grinding up the entire grain must be very small, as by far the largest portion, both of the nitrogen and of the mineral matters now rejected, are not capable of digestion and assimilation.

Non-crystalline Products of the Action of Diastase upon Starch.—H. T. Brown and Dr. G. H. Morris.—From *Liebig's Annalen.*

Application of Electricity in the Sugar Manufacture.—Prof. H. Landolt, Dudok de Wit, J. Görz, and others.—No results of importance have been reached. There is a complaint against the morbid desire to effect everything by electricity.

Journal de Pharmacie et de Chemie.
Series 6, Vol. xiii., No. 11, June 1, 1886.

Determination of Organic Carbon contained in Soils which Fix Free Nitrogen.—M. Berthelot.—Already noticed.

Chemical Characteristics of the Different Kinds of Digitaline.—M. Lafon.—The digitaline of French make is identical with the digitoxine of Merck, of Darmstadt.

Note on the Pichi of Chili.—L. Limousin.—A pharmaceutical paper.

Determination of Acid Magenta in Wine.—M. Sambuc.—Already noticed.

Coal-Tar Colours from a Sanitary Point of View.—P. Cazeneuve.—The author considers that the addition to wine of colouring-matters, whatever they may be, ought to be energetically proscribed.

Oxidation of the Fatty Acids.—H. Carette.—The author considers that the lipic acid of earlier authors is probably identical with normal propylene dicarbonic acid.

No. 12, June 15, 1886.

On Ephestia Kuenhilla.—An account of a newly introduced moth which infests granaries.

A New Note on Acid Magenta in Wines.—P. Cazeneuve.—A reply to the memoir of M. Sambuc in the last number of the *Journal de Pharmacie et de Chimie.*

Researches on the Physiological Action of Urethane and on its Properties as a Functional Antagonist of Strychnine.—Prof. Coze.—Urethane has a manifest hypnotic action; it slackens the pulse and the respiration and lowers the temperature. It is the functional antagonist of strychnia and might be useful in tetanus.

MISCELLANEOUS.

Appointment.—Mr. H. Lloyd Snape, B.Sc., formerly Demonstrator of Chemistry at University College, Liverpool, has been appointed Lecturer on Chemistry and Chemical Technology at the Manchester Technical School.

Manchester Technical School.—On Friday evening (July 23) the students attending the Manchester Technical School assembled in strong force in one of the lower rooms of the Institute, and presented an illuminated address, a microscopic slide cabinet, and half-a-dozen volumes of Professors Roscoe and Schorlemmer's Treatises on Chemistry and Spectrum Analysis to Dr. A. B. Griffiths, F.R.S. (Edin.), F.C.S. (Lond. and Paris), as a mark of esteem and respect and affectionate regret at his departure from the school, where he has laboured as a lecturer and scientist with marked success. The chair was occupied by Mr. Harold Follows, F.C.S., and the presentation was made by Mr. Asher-Aron. Dr. Griffiths acknowledged the gifts, and then spoke of the importance of original research as a means of enlarging the mind, pushing forward the bounds of knowledge, and also for the good of humanity. The address speaks of Dr. Griffiths's "masterly and vigorous discourses," to the "honour he has conferred upon the School by his brilliant and ingenious researches," and to "the warmth and cordiality with which Dr. Griffiths has at all times met the demands of individual students," and also to "the hearty and inspiriting personal sympathy with which he has so uniformly tendered his invaluable advice and assistance." The cabinet mentioned as one of the gifts is capable of holding 500 slides. It contains a large number of biological and pathological slides, and is also inscribed with a silver plate. Dr. Griffiths has recently been appointed Head Master and Lecturer on Chemistry and Physiology at the new School of Science of the City and County of Lincoln.

Etched Figures and Arrangement of Atoms.—W. S. B.—The method of "etched figures," which within the past few years has proved so successful in the detection of hemihedral and tetartohedral forms on crystals which appear to be holohedral, bids fair to play some part in the discussion regarding the position of the atoms in the molecules of crystalline substances. When Linnæite (Co_3S_4) is treated with acids its cubic faces are most readily attacked. When treated with fused potash, however, the solution takes place most rapidly in the direction of the dodecahedral planes. This fact leads F. Becke (Tschermak's "Min. und Petrogr. Mitt." 8, 195) to observe that probably the cobalt atoms in the molecule are turned towards the cubic faces and the sulphur atoms towards the dodecahedral faces. Whether the use of this method will throw any light on the position of the atoms in space is doubtful. It is probable, however, that it will help to an understanding of the forces which act in the formation of crystals.—*American Chemical Journal.*

THE CHEMICAL NEWS.

Vol. LIV. No. 1393.

ON RADIANT MATTER SPECTROSCOPY.*

Part II.—Samarium.

By WILLIAM CROOKES, F.R.S.

(Continued from p. 57).

Mixed Samarium and Yttrium Spectra.

146. It was interesting to ascertain what spectrum a mixture of samarium and yttrium would give. A mixture of 90 parts of samaria to 10 of yttria was treated with sulphuric acid and then ignited, and afterwards examined in the radiant-matter tube. The result was as remarkable as it was unexpected. Scarcely a trace of the yttrium spectrum could be detected. The powder phosphoresced with moderate intensity, but the spectrum was almost the facsimile of that given by pure samaric sulphate (137, Fig. 3), except that the sharp orange line, which in the spectrum of pure samaric sulphate is only just visible, had gained sufficiently in intensity to be measurable, and was found to lie at 2693. I next tried a mixture of samaria 80, and yttria 20. The spectrum was identical with the one last observed, with one striking difference—the 2693 line now shines out with great brilliancy of a fine orange-red colour, as sharp as a gas line, and so unlike the bands usually met with in the spectra of phosphorescent earths as to suggest the explanation that some other spectrum-forming body was present in the mixture.

The next tube experimented with contained 70 parts of samaria and 30 parts of yttria. The spectrum was identical with the one last observed. The sharp orange line was present in full intensity.

147. Mixtures were now made of samaria 60, yttria 40; samaria 60·63, yttria 39·37 (equivalent proportions of the two earths); in this last a slight division could be detected in the green band. The following experiments were continued; mixtures were prepared in the following proportions:—

Samaria.	Yttria.
58	42
56	44
54	46
53	47
52	48
51	49
50	50
49	51
48	52
47	53
46	54
45	55

The results were almost identical with those yielded by the previous mixtures. The green band gradually condensed into two bands at $\frac{1}{\lambda^2}$ 3133 and 3199 as the proportion of yttria increased; the first green band was stronger than the other, and the wide orange band began to show signs of a wing on the side next the green. At this stage the spectrum nearly resembled the lead-samarium spectrum (145, Fig. 6). Very little of the yttria spectrum could be detected, and the brilliant orange line stood out sharply in the whole series.

In the next mixture—samaria 44, yttria 56—a faint band $\left(\frac{1}{\lambda^2} 3038\right)$ was visible by the side of the two green bands, in the position occupied by the yellow band of yttria.

148. The experiments were continued, and the following mixtures were made and carefully mapped:—

Samaria.	Yttria.
43	57
42	58
41	59
40	60
39	61

The faint line first observed in samaria 44, yttria 56, gradually got stronger, and there were also signs of a double green band in about the position occupied by the yttrium green.

149. The change which had been rapidly coming over the spectra since samaria 43, yttria 57, was now nearly accomplished, and in the next trial mixture—samaria 35, yttria 65—the only indication that could now be found of the samarium spectrum was seen in the two faint green bands next to the citron line of yttria, a faint yellow band, and the new orange line, which shone out as brightly and sharply as ever.

The series was continued:—

Samaria.	Yttria.
30	70
25	75
20	80
10	90
5	95

In each case a careful map of the spectrum was taken on the $\frac{1}{\lambda^2}$ scale, and each spectrum was found to be practically identical. Slight differences in the relative intensities of some of the bands were observed; but the general character of the spectrum was unaltered. The yttria spectrum now shone forth with scarcely any band of samaria, except that, standing out beyond the other bands in sharpness and brilliancy, the 2693 line was present in all.

150. It will be remarked that a sudden change occurs between the two mixtures, samaria 45, yttria 55, and samaria 35, yttria 65; on one side the spectrum pertains to that of samaria, whilst on the other side the spectrum is that of yttria, the new orange line running equally across them all.

151. The diagrams of some of these intermediate spectra shown in the accompanying figures illustrate how sudden is the transformation from the samarium to the yttrium spectrum. Fig. 7 is the spectrum of a mixture of 44 parts samaria and 56 parts yttria, and except for the increased strength of the orange line, and a faint trace of the red and yellow yttria bands, it is the pure samarium spectrum. Fig. 8 is the spectrum of 42 samaria and 58 yttria, and is built up of some of the component bands of the spectrum of each earth; whilst in Fig, 9, the spectrum of 39 samaria and 61 yttria is seen to be almost the yttria spectrum.

152. I have already shown (86) that one part of yttrium can be detected spectroscopically in the presence of a million parts of calcium, and the reaction is almost as sensitive if other earths are taken instead of lime. Again, the spectrum test for samarium is, if possible, even more delicate (156 to 163), one part being detectible when mixed with more than two million parts of calcium.

153. The accompanying diagram (Fig. 10) shows at a glance the remarkable effect these two earths have of masking each other's spectrum reactions. The ordinates above the horizontal zero line represent the percentages of samaria in the mixtures examined, and the lower ordinates show the percentages of yttria present. The dots on the horizontal line show the actual mixtures experimented with (146 to 149). The part to the left covers the mixtures showing a preponderance of the samarium

* A Paper read before the Royal Society, June 18, 1885.

Fig. 7.

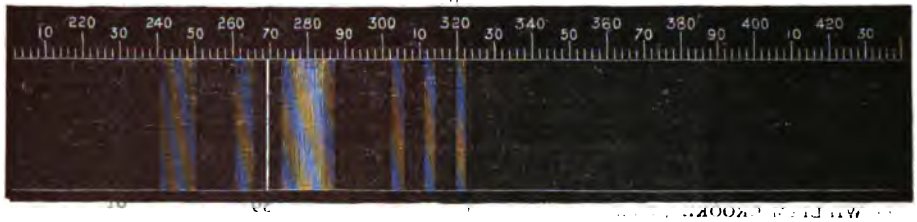


Fig. 8.

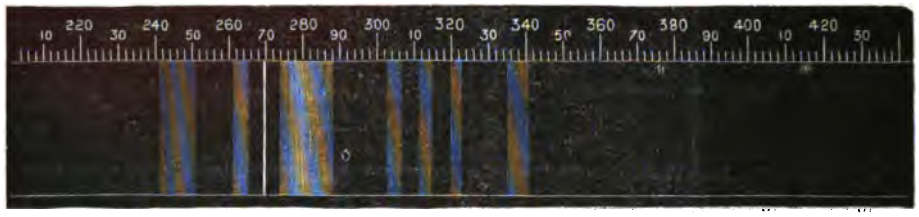


Fig. 9.

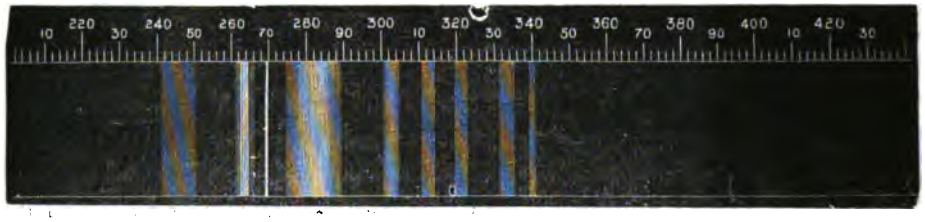


Fig. 10.

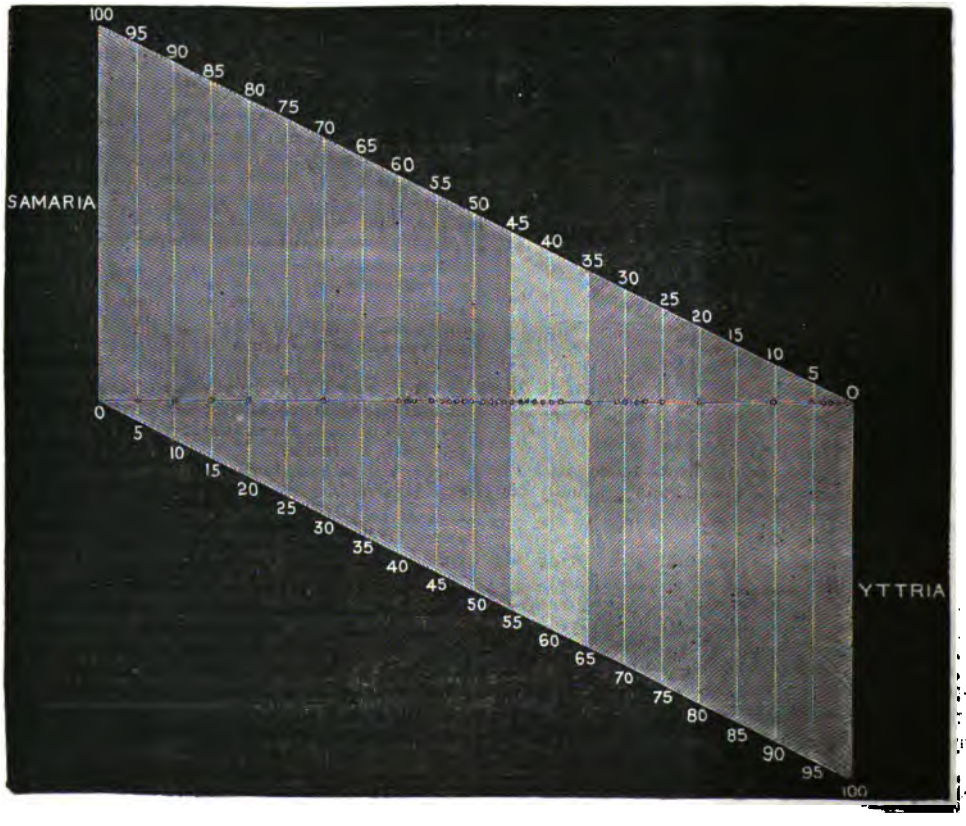
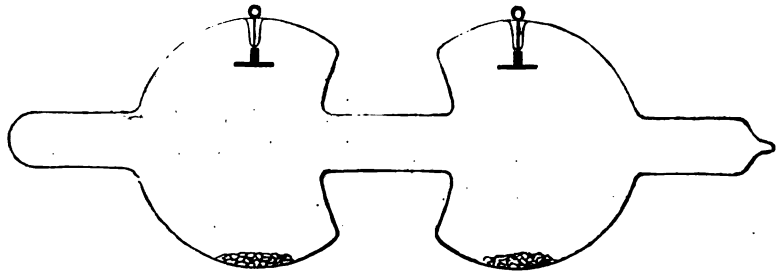


Fig. 11.



spectrum, and the right-hand portion shows the mixtures which give preponderance to the yttrium spectrum only. The intermediate portion covers the narrow border-land in which the fainter mixed spectra were observed.

In no mixture does the resulting spectrum contain the complete spectrum of either earth, many bands of each being suppressed.

154. It was of interest to ascertain whether the orange line 2693 could be evoked by mechanically forming a mixture which, when prepared chemically, gave the line strongly.

A radiant-matter tube was made in the form of a double bulb, as shown in Fig. 11.

In one half was introduced ignited samaric sulphate, and in the other half the same weight of yttric sulphate, each being finely powdered. The tube was well exhausted, and the powders separately examined with the spectroscope. Each gave its characteristic spectrum (72, 137). The double bulb was now sealed off, and the powders well mixed by violent agitation. On careful examination it was seen that the spectrum shown by the mixture was simply that of the two components superposed, and had no resemblance to the spectrum shown by a similar mixture prepared by solution and chemical action (Fig. 13).

The Action of Calcium on the Samarium-Yttrium Spectrum.

155. The addition of calcium to mixtures of samarium and yttrium has the effect of greatly developing the samarium spectrum, and, *pari passu*, of impairing the sharpness of the bands of the yttria spectrum. This exaltation of the samarium bands is not, however, effected without a corresponding loss. The brilliantly sharp orange line 2693 entirely disappears.

Fig. 12.

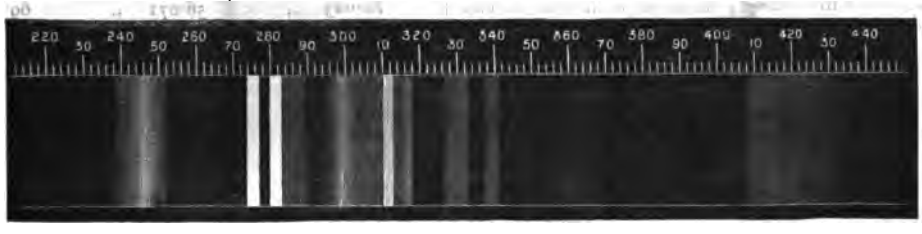


Fig. 13.

Fig. 14.

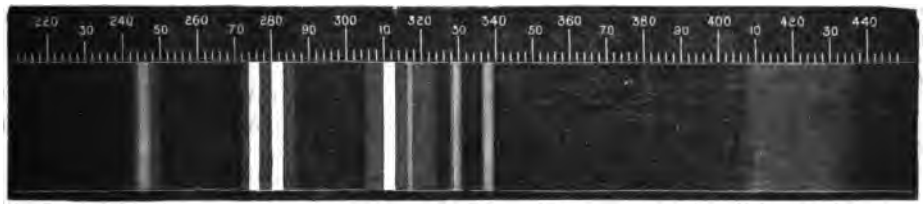


Fig. 12 is a drawing of the spectrum given by a mixture of equal parts of samaria, yttria, and lime. On comparing it with Fig. 13, which represents the spectrum given by the same mixture without the lime, it will be seen that the action is as might have been anticipated from previous experiments. The lime has divided the samarium orange band and strengthened the red, whilst it has increased the brilliancy of the yttrium citron and green, and brought out the blue and violet bands.

Fig. 14 is a representation of the spectrum given by a mixture of samaria 2, yttria 54, and lime 44. Even with this large amount of yttria present the samarium spectrum greatly overpowers that of yttrium. Without the lime very little samarium would be visible in this mixture (149).

(To be continued).

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 53.)

On the Materials employed in the Experiments.

SILVER has been the standard in all these researches, since no other body has ever been obtained in such a pure state. M. Stas considers that distilled silver is the purest possible, and has served as the standard of comparison for silver from other sources. This comparison is made by the wet method; different titrations of the same silver agree within 1-100,000th†.

Since Dumas's discovery‡ that silver melted with nitre can retain as much as 25-100,000ths of its weight of oxygen, many chemists have been led to consider M. Stas's silver to be contaminated with this impurity. I cannot share these doubts so long as it is not disproved that the titration of M. Stas's own silver or of silver prepared *exactly* according to his instructions increases by heating to 600° *in vacuo*.

The chlorides and bromides of potassium and sodium always contained a few 1-100,000ths of silica, which was accurately weighed by subliming these salts in a current of nitrogen. I have admitted that this anhydrous silica was simply mixed with the chlorides. It is, however, not impossible that the silica might exist, at least partially, as an alkaline salt. In this last supposition the correction will become greater in the case of the relation between silver and the chlorides or bromides, and less for that between the chlorides and nitrates.

The calculations of relationships between simple and compound bodies, such as that of atomic and molecular weights, are always founded on the *actual* weights of the substances employed. The reduction *in vacuo* is indispensable, but save a few evident errors I have throughout taken the figures as I find them in the memoirs, inasmuch as M. Stas‖ has but rarely given the specific weight which he takes, and the weight of a litre of air at the moment of weighing.

In the following tables I have marked with an asterisk the weights (in grms.), the proportions, and the atomic weights, which differ sensibly from those found in the Memoirs. The maximum and the minimum of a table are shown by M and *m*. The letters α, β, γ, followed by a number, indicates the memoir and the page.

α. Bulletin de l'Académie de Belgique, August, 1860, vol. x., p. 208—336.

β. Memoirs de l'Académie de Belgique, 1865, vol. xxxv., p. 1—311.

γ. Memoirs de l'Académie de Belgique, 1882, vol. xliii., p. 1—103.

I have considered the most reliable proportion to be the arithmetical mean of all the determinations of the same kind, except in such cases when M. Stas himself has shown reasons for excluding any of them.

I. *Synthesis of Sulphide of Silver*, α 225.

Silver.	Sulphide of Silver.	$Ag_2 : Ag_2S = 100$.
59·4225 grms.	68·24823 grms.	114·8525*
104·139 ,,	119·6078 ,,	114·8540*
191·9094 ,,	220·4158 ,,	114·8541 M
150·000 ,,	172·2765 ,,	114·8510
249·076 ,,	286·061 ,,	114·8489 m

Average 114·8521
Log. = 2·0601389

II. *Analysis of Sulphate of Silver*, α 327.

Sulphate of Silver.	Silver.	$Ag_2SO_4 : Ag_2 = 100$.
72·137 grms.	49·919 grms.	69·2003
60·251 ,,	41·692 ,,	69·1972 m
81·023 ,,	56·071 ,,	69·2038
83·115 ,,	57·523 ,,	69·2089 M
55·716 ,,	38·5595 ,,	69·2072
63·922 ,,	44·2355 ,,	69·2023

Average 69·2033
Log. = 1·8401268

III. *Synthesis of Chloride of Silver*, α 247.

Silver.	Chloride of Silver.	$Ag : AgCl = 100$.
91·462 grms.	121·4993 grms.	132·8413 m
69·86735 ,,	92·8145 ,,	132·8438*
101·519 ,,	134·861 ,,	132·8431
108·549 ,,	144·207 ,,	132·8497* M
399·651 ,,	530·920 ,,	132·8459
99·9925 ,,	132·8382 ,,	132·8482
98·3140 ,,	130·602 ,,	132·8417

Average 132·8448
Log. = 2·1233446

As in the sixth estimation an augmentation of weight was impossible, M. Stas considered the following relationship to be more exact.

Log. = 2·1233616 .... 132·850.

(To be continued).

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.

† It is not easy to understand how this can be possible with a pipette whose drops had a variation of 4-100,000ths. I cannot imagine why M. Stas measured his saline solution instead of weighing it, as Gay-Lussac ("Instruction," p. 11) advised, for researches requiring great accuracy.

‡ *Annales de Chimie et de Physique*, 1878, vol. xiv., p. 294. M. Marignac suspected this cause of error; *Archives des Sciences Physique et Naturelles*, 1860, vol. ix., p. 104. In any case we gain nothing by Prout's theory as M. Stas has explained (*Bulletin de l'Académie de Belgique*, 1880, vol. l., p. 417).

‖ I only recall the following points which concern these specific weights determined by M. Stas:—

NaCl = 2·125 to 2·150 (α 274).
NaCl = 2·145 (β 41).
NH_4Br = 2·456 (γ 45).

then M. Stas has admitted:—

According to M. de Marignac,	$AgNO_3$ melted	=	5·38.
,, ,, Pierre,	Br ,,	=	3·187.
,, ,, Troost,	$LiNO_3$,,	=	2·442.
,, ,, Kresners,	NaBr ,,	=	3·079.

In several places, for example (γ 75) we find indicated how much a body, weighed in air with platinum weights, loses per grm. more than these latter. But in going over these calculations I noticed that M. Stas does not always use the same density for air.

ELECTROLYSIS OF AN AMMONIACAL SOLUTION WITH COKE ELECTRODES.

By A. MILLOT.

IN a memoir presented to the Academy, August 17th, 1885, the author announced that on electrolysing retort-coke purified with chlorine with a solution of ammonia containing 50 per cent of liquid ammonia, he obtained a black liquid, and that this liquid if evaporated in the water-bath left a residue composed chiefly of azulmic matters. This residue, if exhausted with alcohol in a cohobator yields a yellow alcoholic solution, and the black matter remains insoluble. In the former paper he mentioned that the alcoholic liquid, evaporated to

dryness, leaves a residue soluble in boiling water but insoluble in cold water, and that after a great number of successive evaporations and of resolutions to separate the matter insoluble in the cold there remained a syrupy liquid in which appeared a crystallisation of urea capable of being separated by draining and successive crystallisations.

He has subsequently found that the alcoholic solution contains not merely urea, but the derivations of that substance which are generally obtained by the action of heat upon urea, such as ammelide, biuret, and guanidine.

To isolate these bodies the alcoholic solution derived from the exhaustion of the black matter, which is always slightly acid, is treated with basic lead acetate after saturation with ammonia. There is formed an abundant precipitate of ammelide. The filtrate is then decomposed with sulphuretted hydrogen and evaporated to the consistence of syrup. A strong hot alcoholic solution of oxalic acid is added, and on cooling there appears a crystallisation of urea oxalate, which is washed with alcohol and is then decomposed in a boiling solution with calcium carbonate. The pure urea is then allowed to crystallise. The solution from which the urea has been separated is treated at a boil with chalk and then with lime-water. It is filtered and the excess of lime is removed by means of ammonium carbonate. The liquid obtained then contains biuret and guanidine nitrate. The nitric acid is derived from the electrolysis of the ammonia, but it is not generated in sufficient quantity to form urea nitrate, since urea may be obtained directly by crystallisation from the crude alcoholic solution. Biuret is separated from guanidine nitrate by crystallisation in a dilute liquid. Biuret being the less soluble crystallises first in the form of warts. These warts, re-dissolved, yield biuret absolutely pure, which crystallises in needles after several re-crystallisations from dilute ammonia and alcohol. The mother-liquor after concentrating deposits an abundant crystallisation of guanidine nitrate, which is purified by successive crystallisations in water and alcohol. It forms hexagonal tables, of which three edges are often suppressed, yielding crystals in the form of triangles. The biuret and the guanidine nitrate thus obtained have exactly the known properties and the percentage composition of these bodies. As for the yellowish-white matter separated in the first place on the evaporation of the alcoholic solution, or on the precipitation with basic lead acetate, it is purified by several dissolutions in heat and precipitations in cold. A little matter which has become insoluble (probably by polymerisation) is separated each time and the boiling solution is treated with basic lead acetate. It is filtered and the liquid is decomposed in heat with sulphuretted hydrogen. The concentrated liquid deposits on cooling a white matter, which when dried gave on analysis the composition and the properties of ammelide (melanuric acid of Gerhardt). The silver salt has the percentage composition of silver ammelidate.

We obtain, therefore, in this electrolysis, by the direct action of coke upon ammonia, an azulmic matter the oxidation-products of which the author is studying; urea and its decomposition-products, ammelide, biuret, and guanidine. The urea and the guanidine spring probably from the actions of nascent carbonic acid upon ammonia with elimination of water. Biuret is probably formed by the reaction of carbonic acid upon guanidine, and ammelide from the action of carbonic acid and urea upon biuret. The author has not observed among these products the formation of cyanuric acid. It ought to be formed by the action of carbonic acid upon biuret, probably in consequence of the pressence of ammonia, which under these conditions gives rise to ammelide.

Bartoli and Papasogli have electrolysed coke in an ammoniacal solution, but to render the liquid more conductive they added a solution of common salt. The result was the production of nascent chlorine, by which the abovementioned products were destroyed.—*Comptes Rendus*, ciii., p. 153.

ON A PECULIAR VARIETY OF CALAMINE FROM SIBERIA.

By Dr. A. B. GRIFFITHS, F.R.S. (Edin)., F.C.S., and S. DREYFUS.

WE have made an investigation of a peculiar variety of zinc carbonate (calamine) which occurs in the south-west of Siberia. It is associated with barium sulphate and galena, which are imbedded in a matrix of limestone rocks.

On submitting the calamine to analysis, the *crystals* gave the following composition :—

Zinc	50·026 per cent.
Iron	2·773 ,,
Cadmium	0·921 ,,
Manganese	0·120 ,,
Silica	5·620 ,,
Carbonic acid	35·210 ,,
Water	5·330 ,,
	100·000

This specimen of calamine had a hardness between 5 and 6, and a specific gravity of 4·629. Its crystalline form was that of a right rhombic prism belonging to the prismatic system. It was also noticed that twining amongst the crystals was not uncommon. We have never heard that calamine ($ZnCO_3$) has ever been found in this crystalline form before; when it is found crystallised it assumes the form of rhombohedrons. Therefore calamine appears to be a dimorphous compound, and is isodimorphous with the two crystalline forms of carbonate of calcium, namely calcite and aragonite.

Technical School, Manchester.

ESTIMATION OF CAUSTIC IN CAUSTICISED SODA LIQUOR.

By WILLIAM UPWARD.

IN the CHEMICAL NEWS (vol. liv., p. 28) appeared a short article bearing somewhat upon this subject, and written by H. Joshua Phillips. Previously to its appearance experiments on the subject had taken place in the laboratory with which I am connected for the purpose of *accurately* checking the workmen. As is customary at all alkali works, samples of causticised liquor are taken by us at regular intervals and tested by the $BaCl_2$ method. Knowing fully well that two or more chemists, experimenting upon the same samples, rarely arrive at corresponding results, the discrepancies being from two to three, or even more, per cent, we determined to try and ascertain the cause of the want of agreement. Accordingly a certain sample was selected and kept in a stoppered bottle as long as the series of tests continued. The first experiment was for the purpose of estimating the total quantity of alkali; this known, the same volume of liquor was measured, to which $BaCl_2$ was added, and the whole made up to 500 c.c.; half of this was then filtered and titrated. The results of seven tests was 88·68 parts of alkali as caustic per 100 of total alkali. Seven tests were afterwards made upon liquor poured off from the sediment instead of upon filtered liquor, and after treating each in a precisely similar manner we obtained 90·85 as a result. Five experiments were subsequently made upon the precipitate produced and titrating, and 91·96 was the result.

In each test distilled water that had been boiled and allowed to cool in a stoppered bottle was used. Various known quantities of $BaCl_2$ were also employed, and, although in some cases there was a large excess, the results were not affected.

From the facts obtained we can only conclude that it

is absolutely essential that tests be made in exactly the same way in order to secure anything approaching concordant results.

In estimating the carbonate in white caustic we weigh out about 20 grms., dissolve in H_2O, add $BaCl_2$, and place the whole in a stoppered bottle not less than one litre in capacity, and fill up to neck with hot H_2O. After complete settlement the clear liquor is syphoned off and the bottle re-filled with hot H_2O. After a second syphoning the precipitate is poured on to a filter and washed until the filtrate is freed from alkali, which does not take long after the washing in stoppered bottle. The precipitate and filter are removed from the funnel into a beaker or flask, and a known volume of standard HNO_3 or HCl in excess is run in; standard soda being employed to bring back. We find no difficulty in making two tests from one sample, with no greater discrepancy than 0·05 per cent by this method.

Deacon Road, Appleton-in-Widnes.

ON THE DETERMINATION OF ABSOLUTE NEUTRALITY.

By J. R. DUGGAN.

As some confusion exists in the use of the terms "acidity" and "alkalinity," it seems necessary to state the exact sense in which they are used in this article. It is customary to consider alkalinity as having some connection with the property of certain bodies to combine with acids to form salts and water, but this is more properly called basicity, and it is by no means necessary that a base should be alkaline, or that an alkaline body should be a base. Sodium carbonate is distinctly alkaline, but does not combine with acids, while phenol, which even has acid properties, will, under proper conditions, unite with an acid to form a salt and water. With the term acidity the difficulty is greater, because there is no other word in common use that may be used to express one of its meanings. There certainly are bodies, however, that show acid properties, but do not unite with bases to form salts, as many salts of the heavy metals; while other bodies that are neutral or slightly alkaline, will unite with bases to form salts and water, as, for example, primary alcohols. In fact, a certain substance may act as an acid or base according to circumstances, but it cannot show both acidity and alkalinity. Unless otherwise stated, the term acidity when used in this article means the opposite of alkalinity, rather than of basicity. The necessity for this distinction will, I hope, be better appreciated when the following experiments are taken into account. It must not be understood from the above that the acidity of *acids* and the alkalinity of *bases* has no connection with the *avidity to combine* or *affinity* which acids show for bases and bases for acids.*

The Influence of Mono- and Poly-basic Acids, in the Presence of their Sodium Salts, on the Conversion of Starch by Diastase.

These experiments were undertaken in order to compare the action of organic acids and alcohols on soluble ferments with their action on organised ferments, and are a continuation of some former studies on the relation between chemical constitution and physiological action.† One of the principal objects in the work was to ascertain whether or not the action of acids on diastase was proportional to their affinity. Diastase was selected because it is a typical soluble ferment, and one whose action in converting starch into dextrin and sugar is comparatively simple and easily measured. As some of the results obtained are of chemical interest, aside from any connection they may have with physiology, it seems best to consider these separately. As the subject is still under investigation, what is contained in this article must be taken to a certain extent as a preliminary notice.

The amount of acid necessary to retard the action of diastase has been investigated by several observers, and with widely different results in each case; but the recent work of Chittenden and Cummins* has shown that this is due for the most part to the fact that different specimens of malt-extract and starch contain varying amounts of proteid matter, which combines with the acid and prevents its retarding action. They find that the acid proteids which are thus formed may even accelerate the action of the ferment. I have found that the normal salts of many acids also prevent the retarding influence of acids, just as they retard or prevent the action of acids in inverting cane-sugar.† By preparing reagents as free as possible from foreign substances, and using very dilute starch-paste, I have been able to reduce the amount of even comparatively weak acids, such as formic, that is necessary to distinctly retard diastatic action, to 0·0002 per cent (1 to 500,000) while 0·001 per cent entirely prevented action. It is evident from this that the common statement that diatase acts best in a slightly acid solution applies only to such as contains proteids or salts with which the acid may combine, and not remain free to act on the diastase. If it were possible to prepare both starch and diastase perfectly pure, it is probable that any appreciable quantity of the stronger acids would prevent the action of the ferment.

The influence of alkalies on diastase is even more marked than that of acids; so it will be seen that it is an extremely delicate indicator of acid or alkaline reaction. The practice of using litmus, phenolphthalein, and similar substances for this purpose is so common that we fall into the belief that they show absolute neutrality; but this is by no means true, and a disregard of this point must lead to grave errors in chemical and physiological investigations. A number of substances will react acid with one indicator and alkaline with another, as, for example, di-sodium phosphate;‡ or we may have an acid or base that is too weak to affect the indicator, as boric acid or urea, in which case the solution will appear neutral when it is not. We may also have a strong acid combined with such a base, or *vice versa*, so that the acid will act on the indicator as though it were uncombined, but it certainly does not act in many chemical reactions or on living organisms in such a manner. As an example, sodium borate or carbonate acts on some indicators as caustic soda, and can be titrated as such, but a more striking illustration is the titration by means of phenolphthalein of the acid combined with alkaloids as free acid.§ While sodium borate and carbonate are alkaline, they are certainly not as much so as caustic soda, and the same is true of the acid in morphine sulphate and similar salts of the alkaloids. With nearly all indicators the presence of proteid matter does not affect the accuracy with which acids may be determined, but, as already mentioned, the work of Chittenden and Cummins has shown that there is present in such cases a compound which acts entirely differently from the free acid. By the selection of indicators to suit the conditions something may be done to avoid these difficulties, but there will still remain many cases of acidity or alkalinity which cannot be measured by any of the ordinary methods. Ostwald‖ has shown that each acid has a definite strength or affinity-constant which conditions the specific intensity of any action brought about by that acid. This constant may be determined by several methods, the most reliable, since it is free from secondary reactions, being based on the rate at which the acid inverts cane-sugar. It appears that each base also has its affinity-constant, although the methods by which this may be determined are not so well

* See Muir's *Principles of Chemistry*, p. 401 *et seq.*
† *Amer. Chem. Jour.*, vii., 62.

* *Studies Lab. Physiol. Chem. Yale College*, 1884–5, p. 36.
† *Jour. f. prak. Chem.*, lxxxv, 321, and (2) xxxii., 32.
‡ *Compt. Rend. de l'Acad.*, c., 55.
§ *Journ. Pharm.*, (5) xi., 425.
‖ *Jour. f. prak. Chem.*, (2) xxix., 57.

developed as in the case of acids. Let us now suppose that two salts are formed by the addition of two acids to a base, as sodium chloride and sodium acetate. These salts are neutral to all colour indicators; and if this neutrality is absolute, it would seem that an equivalent of any acid can neutralise, and is neutralised by, an equivalent of any base without regard to its affinity, for these two acids differ greatly in this respect. This is the same as saying that the acid properties of an acid, and the alkaline properties of a base, are entirely destroyed when the two combine to form a normal salt. That such is not the case may be shown with the ordinary colour indicators, but only when there is very great difference in the affinities of the base and acid, as with alkaline carbonates or sulphates of some of the heavy metals. That sodium chloride does not turn blue litmus red, and sodium acetate the reverse, is due to the fact that litmus is not sufficiently delicate as an indicator to respond to the comparatively weak acid and alkaline reactions of these salts. That the salts are respectively acid and alkaline is shown beyond doubt by the investigations of Löwenthal and Lensen,* and more especially of Spohr,† on the inversion of cane-sugar, and by their influence on diastatic action in the presence of acids. The addition of sodium chloride to hydrochloric acid increases the rate at which it inverts cane-sugar, while sodium acetate has an opposite effect on acetic acid. The amount of hydrochloric acid required to retard to a certain extent (50 per cent) the action of diastase is so small that it is difficult to say if this is diminished by the addition of sodium chloride; but the increase in the amount of acetic acid that is made necessary by the addition of sodium acetate is very marked, and is proportional to the amount of the salt added. This is very well shown by the following table. The amount of conversion with diastase and starch-paste alone is shown by the control experiment. The solutions were in each case made up to 100 c.c., and the flasks containing them kept in a water-bath at 55° C. for thirty minutes, when the action of the ferment was stopped by the addition of an excess of caustic soda. The amount of sugar formed was determined volumetrically by Fehling's solution, and calculated as maltose.‡

Table I.

	NaOH.	$C_2H_4O_2$.	Maltose.	Per cent of retardation.
1	0·000 grm.	0·000 grm.	0·420 grm.	—
2	0·000	0·001	0·204	51·4
3	0·005	0·045	0·215	48·8
4	0·010	0·090	0·213	49·3
5	0·015	0·135	0·210	50·0
6	0·020	0·180	0·210	50·0
7	0·030	0·270	0·207	50·7
8	0·040	0·360	0·205	51·2

It will be seen that the retardation is not quite constant, but increases slightly with the amount of alkali and acid present. This is probably due to the action of the substances aside from any condition of alkalinity or acidity. This secondary action, as it may for convenience be called, is very marked with some substances, such as salts of the heavy metals, and when such is the case, of course the reaction cannot be used to measure alkalinity or acidity; but with the alkali metals and most organic substances, the error from this source is very small unless they are used in large quantities. If the retarding action of any substance is partially or entirely prevented by the presence of an acid, it seems fair to conclude that it is to that extent due to alkalinity of the substance, and *vice versa*; but when it is not affected by either acids or alkalies, it is evident that it acts on the ferment in some other manner.

The table shows that in the presence of 5 m.grms. of caustic soda, 45 m.grms. of acetic acid are necessary to produce the amount of retardation caused by one m.grm. acting on the starch and diastase alone. (Of course the use of reagents of greater or less purity will cause the amount of acid to vary, so that more or less than 1 m.grm. may be required; and with perfectly pure materials it is impossible to say to what extent this would be reduced.) Now 7·5 m.grms., or one-sixth of the 45 m.grms. of acid, combine with the 5 m.grms. of caustic soda to form normal sodium acetate; and we must suppose that this normal salt neutralises to a certain extent the remaining 37·5 m.grms., or five equivalents of acid. In order to do this sodium acetate must be an alkaline salt, or one in which the affinity of the acid is less than that of the base. The following table shows this to be the case:—

Table II.

	NaOH.	$C_2H_4O_2$.		Maltose.	Per cent of retardation.
1	—	—		0·428 grm.	—
2	0·020 grm.	0·015 grm.	= ½ equiv.	0·000	100
3	,,	0·030	1 ,,	0·363	15·0
4	,,	0·060	2 ,,	0·428	0·00
5	,,	0·090	3 ,,	0·396	7·5
6	,,	0·120	4 ,,	0·360	15·9
7	,,	0·150	5 ,,	0·290	32·2
8	,,	0·180	6 ,,	0·225	47·4
9	,,	0·210	7 ,,	0·152	64·5

The second experiment of this series is introduced to show that an excess of caustic soda acts as though there were no acetate present; that is, that the normal salt does not prevent the action of alkalies as it does that of acids. In this case one-half the soda combines with the acid, leaving 10 m.grms. free; but if such an amount of acid is used that only 1 m.grm. is left free, the result would be the same, no action taking place. In the third experiment the acid and base were added in the proportion of their combined weights, so there was present only the normal salt. This retards the reaction 15 per cent; but when another equivalent of acid is added, as in No. 4, the conversion is the same as in the control experiment, showing that the solution is neutral. When more than two equivalents of acid are added, we again get retardation from acidity.

(To be continued.)

* *Journ. f. prakt. Chem.*, lxxxv., 321, 401.

† *Ibid.*, (2)xxxii., 32.

‡ For greater details of the method used in determining diastatic action see *American Chemical Journal*, vii., 306.

CONTRIBUTIONS TO OUR KNOWLEDGE OF SEWAGE.

By WILLIAM RIPLEY NICHOLS and C. R. ALLEN.

In the year 1872 one of us had occasion to report* the results of the chemical examination of a considerable number of samples of the sewage of Boston and of Worcester, Mass. The examinations then made included the determination of the nitrogen existing as ammonia or in the form of ammoniacal salts (tabulated as free ammonia), and of the nitrogen which was given off as ammonia by treatment with an alkaline solution of permanganate of potash, according to the well-known method of Wanklyn. As indicating the total amount of organic nitrogen, this last determination—that of the so-called "albumenoid ammonia"—was felt at the time to be inadequate, but under the then existing circumstances it was the best that could be done.

When Kjeldahl's process for the determination of the total nitrogen in organic substances was published a few years ago,† it suggested itself at once that the method might possibly be conveniently applied to the analysis of sewage. Circumstances have prevented, until recently,

* "Fourth Annual Report of the State Board of Health of Massachusetts." Boston, 1875. Pp. 65-82.

† *Fresenius Zeitschrift*, xxii. (1883), p. 366; Chemical News, xlviii. (1883), p. 101.

EXAMINATION OF BOSTON SEWAGE.

(Results expressed in parts in 100,000).

Number.	Date of collection.	Ammonia.	Albumenoid Ammonia.	Total Nitrogen, reckoned as Nitrogen.	Total Nitrogen, reckoned as Ammonia.	Total solids.	Chlorine.	Chlorine, reckoned as common salt.	Phosphoric Acid (P_2O_5)
1.	1885. May 12, 7.30 p.m.	2·80	0·27	2·80	3·40	592	275	453	0·480
2.	13, 8.20 a.m.	3·18	0·44	3·46	4·20	548	258	425	0·096
3.	13, 7.20 p.m.	3·42	1·15	5·76	7·00	254	82	135	0·672
4.	14, 7.20 a.m.	1·32	0·35	1·81	2·20	570	247	407	0·704
5.*	15, 1.00 a.m.	1·29	0·87	4·63	5·62	482	133	219	1·343
6.*	15, 8.15 a.m.	1·59	0·25	6·00	7·30	416	194	320	0·512
7.	15, 4.00 p.m.	3·08	0·55	3·76	4·57	358	145	239	0·192
8.	16, 7.30 a.m.	0·95	0·55	2·14	2·60	630	311	513	0·288
9.	17, 4.25 p.m.	5·68	5·96	14·53	17·65	554	215	354	7·035
10.	18, 8.00 a.m.	6·23	5·84	13·82	16·78	528	?	?	6·490
11.	24, 7·50 p.m.	11·94	3·32	17·15	20·82	178	59	97	3·325
12.	23, 12·40 a.m.	?	2·62	4·32	5·30	378	178	293	0·992
13.	26, 12 hr. day average†	5·71	4·22	11·32	13·75	460	177	292	4·893
14.	27, 12 ,, ,, ,, †	5·71	3·31	9·55	11·60	640	288	475	6·188
15.	28—29, 24 ,, average‡	3·13	5·49	9·82	11·93	588	240	396	4·702
	1872. Average of 33 day samples§	2·72	0·73	—	—	59	19	31	1·69‖
	,, ,, 4 night ,,	1·33	0·23	—	—	17	4·5	7·4	—

* Samples 5 and 6 contained a good deal of storm water. † Samples taken every four hours. ‡ Samples taken every two hours.
§ Samples from sewers near the water front, which evidently contained much sea-water, were not included in these averages.
‖ Average of 19 samples.

the carrying out of this idea; meanwhile the process has found extensive application, especially in agricultural laboratories, and has been used in the analysis of certain kinds of fertilisers. It is possible that it may have elsewhere been applied to the examination of sewage; if so, we have failed to meet with notice of such application, which we find to be quite practicable and to give satisfactory results.

In order to familiarise ourselves with the process and, at the same time, to become satisfied of its substantial accuracy, determinations of the total nitrogen were made in sulph-urea, in dried and powdered horse-dung, and in dried and powdered human excrement, the amount of nitrogen being checked either by theory or by an absolute determination, according to Dumas's method. The results were as follows:—

	I. Kjeldahl's Method.	II. Dumas's Method.	III. Theory.
Sulph-urea	36·89 per cent	—	36·84
Horse-dung. 1 ..	3·16 ,,	3·28	—
,, 2 ..	3·12 ,,	—	—
Excrement	6·20 ,,	6·08	—

In order to satisfy ourselves as to the constancy of the results obtained in a number of determinations made on the same sample of actual sewage, a sample was procured and analysed with the following results.

Organic Nitrogen expressed as Parts in 100,000.

Kjeldahl (after deducting nitrogen as free ammonia).	Dumas.
3·75	3·66
3·50	—
3·75	—
3·70	—
3·75	—
3·75	—
3·80	—

It thus appears that the process gives uniform results, and that these results are sufficiently accurate for the purpose. It has the advantage of requiring only the ordinary apparatus used in water analysis, as generally conducted in this country, and of avoiding a dry combustion, which, in the simplest form, is more or less troublesome, especially where a liquid has to be evaporated, and the solid residue transferred from the evaporating dish.

There is little doubt that the coming decade will see in this country a considerable application of the method of disposing of sewage by irrigation, and it seems to us that Kjeldahl's process will afford a ready means of determining the amount of that important constituent—the combined nitrogen. The process, as we have used it with sewage, is as follows:—

From 25 to 50 cubic c.c. of sewage are introduced into a small flask, preferably flat bottomed, made acid with sulphuric acid, and evaporated to dryness on a water-bath. This is best and most rapidly accomplished by drawing through the flask a somewhat rapid current of air which has been freed from moisture and ammonia by bubbling through strong sulphuric acid. We have satisfied ourselves that the loss of "free ammonia" by this treatment is inappreciable, so that the residue contains the total combined nitrogen* of the sewage. This residue is treated in the flask with 5 c.c. of fuming sulphuric acid, which is run in from a glass-stoppered burette. The flask is placed on a piece of wire-gauze over a small gas-flame and heated until a light yellowish brown liquid is obtained. With sewage this result is sometimes reached in half-an-hour; usually from one to two hours are required. Permanganate of potash is then added to complete the oxidation, a few crystals being sufficient.†

The contents of the flask are then washed into the distilling apparatus with about 500 c.c. of pure distilled water, enough caustic potash is added to give an alkaline reaction, and the nitrogen, which is now all in the form of ammonia, is distilled off in the usual way. The distillate is made up to 250 c.c. and aliquot portions are nesslerised as in water analysis. As the sulphuric acid usually contains a trace of nitrogenous compounds, a blank experiment determines a slight correction to be applied.

The process as just given may be modified by evaporating the sewage without first acidulating with sulphuric acid. The evaporated water may be condensed and the free ammonia determined therein and an approximate determination of the total solids may be made by using a tared flask. We prefer, however, to proceed as indicated above and to make a separate determination of free ammonia, with which may be coupled, if desired, a determination of the so-called albumenoid ammonia.

* The nitrogen which exists in the sewage as nitrites and nitrates is too small to be of practical importance, although there is usually a trace.

† For fuller details, see Kjeldahl's original paper, referred to above.

Boston Sewage.

Since the examinations of sewage made in 1872, the Boston system of sewerage has undergone an entire change. Instead of being discharged from short sewers emptying at intervals along the water-front, the sewage is now collected into one encircling sewer, carried by means of a tunnel to Moon Island, and allowed to flow into the outer harbour on an ebb tide.

We have examined a number of samples taken from the pumping station at City Point, where the sewage is lifted in order that it may flow through the tunnel to Moon Island. The sewage was received as a rule in a fresh condition; the heavier suspended particles were allowed to subside, and no attempt was made to determine their amount. In fact, the determination of suspended matters in small samples is of little value, and a more practical idea of their amount could be obtained on a large scale by estimating the amount deposited in the settling-tanks. The following table contains the results of the examination of various samples of sewage from the pumping-station. It will be noticed that the samples taken at different times vary very much from each other. The large amount of total solids and chlorine are said to be due to the fact that a considerable quantity of sea-water is used in certain manufactories for cooling purposes and to the infiltration of salt water into the sewers which are below the tide level.

Nitrogen as Urea.

The rapidity with which urea is converted into carbonate of ammonia and water in the presence of the urea ferment which is probably always present in sewage, would prevent its existence in stale sewage, but as the Boston sewage reaches the point from which our samples were taken in a fresh condition, we might expect to discover some of this substance still unchanged.

The evidence that urea was present in several samples which were tested is as follows:—Two portions of 50 c.c. each were boiled in small flasks to expel the free ammonia and to kill any of the ferment present, and the necks of the flasks then stopped with cotton-wool. When the contents had become cool one of the flasks was infected by dipping a glass rod first into a fermenting solution of urea, or into stale sewage, and then into the boiled sample. The two samples were allowed to stand side by side for several days, and then examined for free ammonia in a similar fashion. In one case the flask which had not been impregnated was free from ammonia; generally, however, a small amount of ammonia had developed itself; in all cases the impregnated flasks showed a much greater amount of ammonia than was contained in the companion flasks. This certainly points to the presence of urea or some similar fermentable nitrogenous compound in the sewage as it reaches City Point.

In conclusion we desire to acknowledge our indebtedness to the Department of Improved Sewage for facilities in collecting samples, especially to Mr. Barnes, at Chester Park, and to Mr. M. H. Holmes, at the pumping-station. —*Journal of the Franklin Institute.*

NOTICES OF BOOKS.

The Gas Engineer's Chemical Manual. By J. A. Wanklyn. London: The Scientific Publishing Company, Limited.

The author remarks truly enough in his preface that we must "look to a wide development of the gas industry for the abatement of the smoke nuisance, and for the bringing back of vegetation into many of our towns." But before so desirable a consummation can be reached coal-gas must be purified from sulphur compounds to a far greater extent than it has hitherto been found practicable. It is a familiar observation that plants do not thrive in rooms lighted with gas. It is possible, however, that if the "coal-liming process" noticed in the last chapter of this manual is fairly carried out we may have the convenience of burning a gas free from sulphur.

In the section on coal attention is called to a determination of the percentage of unoxidised hydrogen as found by taking one-eighth of the percentage of oxygen and subtracting it from the percentage of hydrogen. In this important respect Lancashire coal does not maintain its traditional reputation as a gas coal. It is surpassed not merely by certain Scotch cannels, but by the Haswell Wallsend, and by one sample from Wales and one from Somersetshire.

In the chapter on coal-gas Mr. Wanklin advises the determination of sulphuretted hydrogen, ammonia, the oxides of carbon, the special illuminants, such as benzene, carbon disulphide, and organic sulphur compounds. For estimating the illuminants he recommends that the gas should be submitted to the solvent action of a limited quantity of rectified spirit, the decrease of volume being noted after the alcohol has been eliminated.

In speaking of carbon dioxide the author mentions the excessive proportion of this formidable poison in so-called "water gas," *i.e.*, the gas produced by the action of steam upon red-hot coke, as a serious objection to the use of such gas. A fatal objection it doubtless is unless escapes could be absolutely excluded.

Mr. Wanklyn mentions the absolute suppression of carbon monoxide in coal-gas as a desideratum. So it is, but we fear that the successful inventor will find his patent expired before the process is adopted.

The scheme for what may be called the practical testing of coal-gas, as distinct from the complete analysis, is claimed as being, "in a subordinate sense," new and original. It appears likely to meet the demands of the managers of gas works. Particular attention must be called to the method proposed for the volumetric determination of hydrogen sulphide in crude gas, a standard solution of lead acetate being employed.

Among the good features of this work must be mentioned the total absence of "padding." Practical men will not have to seek for the author's meaning amidst a wilderness of unnecessary verbiage. We may safely recommend it as a useful addition to the literature of a subject which is increasing in importance.

CORRESPONDENCE.

RADICAL OR RADICLE?

To the Editor of the Chemical News.

Sir,—I quite appreciate the points urged by Prof. Divers (Chem. News, vol. liv., p. 36) in favour of the first of the above modes of spelling the word, but I cannot admit that they apply to this particular case.

The words ending in *-al*—of which he gives a list—are, with the exception of *menial* (which has an interesting history of its own), and *chemical* (which would hardly be used as a substantive in any decently-written scientific paper), English adaptations of well-recognised Latin words, *e.g.*, "*principalis*." But there is no substantially-used adjective "radicalis" in the whole range of Latin literature, so far as I am aware: not even in the late monkish stuff which finds a place in Ducange's *Glossarium*.

If there was anything to be gained in euphony or conciseness by making the word end in *-cal* instead of -cle (compare the celebrated controversy about "telegram" and "telegrapheme"), it would be a different matter. But since this is not the case, we may just as well spell the word in the etymologically-correct way, as copy an erroneous Gallicism.—I am, &c.,

H. G. Madan.

Eton College, July 30, 1886.

PATHOGENIC MICRO-ORGANISMS IN WATER.

To the Editor of the Chemical News.

SIR,—Referring to the Report on the London Water Supply published in your last issue, I would venture to offer a few remarks on the mention which is here made of experiments on the vitality of the *bacillus anthracis* in water. From the Report it does not appear whether the experiments have been made with the *bacilli* or the *spores* of anthrax, which, as is well-known to students of bacteriology, are endowed with such very different powers of resistance to hostile conditions. From the results obtained, however, it would appear that the bacilli only, and not the spores, had been the subject of experiment, for Dr. Meade Bolton, who has recently published a paper in which he deals with the behaviour of anthrax in both its forms in various kinds of water, has shown that, although the bacilli rapidly become extinct in some kinds of potable water, the spores, on the other hand, retain their vitality even in distilled water for upwards of ninety days, whilst in polluted well-water they were unimpaired after nearly a year. The vitality of pathogenic microbes in water is a subject of great interest, and I have myself been much struck with the differences in behaviour in this respect which are exhibited by specific pathogenic micro-organisms. The results of my experiments with Koch's "comma" spirillum, Finkler-Prior's "comma" spirillum, and the bacillus pyocyaneus, were communicated to the Royal Society in June last. I have found that whilst the bacillus pyocyaneus flourished under almost every condition to which it was exposed, the two others were far more sensitive—the Finkler-Prior spirillum, in fact, being so in such a high degree that in no case was I able to demonstrate its presence in water after the first day of its introduction, whilst Koch's "comma" spirillum could not be demonstrated in the purest forms of potable water after the ninth day, but in sewage it underwent enormous multiplication for upwards of twenty-nine days.—I am, &c.,

PERCY F. FRANKLAND.

Normal School of Science,
South Kensington Museum, S.W.,
July 28, 1886.

SCIENTIFIC EXPERTS IN PATENT CASES.

To the Editor of the Chemical News.

SIR,—Perusing your remarks in reference to the employment of scientific experts in cases of patent infringements, with your permission I will offer a few remarks. The practice has grown, and it must be admitted as inevitable, that such disputes when they occur will have to be settled by scientific opinion; but our present mode of procedure is an expensive one. Highly paid scientific experts are employed to coach counsel also highly paid, on both sides, and naturally on which ever side these may be engaged, their inclinations, in spite of themselves, would sway to that side; with an equal array of talent opposed, some may say it is as fair for one as another, but is it always so? An inventor may have to fight powerful moneyed interests, or trade combinations, and, short of the wherewithal, he runs the risk of suffering grave injustice. These Patent cases are becoming a public calamity, and are knocking the heart out of many earnest inventors; and as the benefits accruing to the world are in a very large measure the result of invention, in some shape the crippled condition, or possibly the ruin, of an inventor brought about by the effort to prove his rights, is a discouraging matter to more than one inventor. These disputes are the result of monopolies. Rightly or wrongly, the public look on a patentee as a monopolist, but he is of no account until his invention is proved of utility and a demand springs up for it; when the greedy and watchful competitor feels it intolerable he should be shut out of it and distanced completely. Failing to bring something out better, he produces a bad imitation or a questionable improvement, and war commences, ending in a ca
law courts. There the lawyers and experts m
matter, and turn it out of hand with quite a n
plexion, such as neither of the contending parti
selves ever experienced (and presumably the
know most about it). If to foster inventive tal
improve our trade, it is surely the interest of all
to combine with the friends of invention and try
a better protection of their interests. The Stat
business in allowing the title of "true and first i
under the present inadequate and non-technical
examining Patents. It is utterly wrong in accep
and granting so-called "protection" and refusing
by its own acts. It is equally at sea in granting
and an unrestricted right to patentees to charge
they like to the public for their inventions, encou
many cases these irritating monopolies. Its grave
perhaps, that it fails to recognise it is a public
ascertain the novelty of inventions, and if t
reasonably proved on technical examination, to
patent at the lowest compatible cost, *and having*
it, after giving the public a voice in the matter,
should support its act.

The fear of complication is dispelled by provi
the public also to make use of the inventions
terms (not fixed by the patentee alone). He
obvious, where all have the same privileges, a m
cannot exist; for the Royalties which are fix
reasonable scale are only to be considered as the
ward and encouragement given to the inventor
ducing his invention. Piracy might try to profit
it would receive its deathblow in that it would
interest of all concerned in the invention (indep
of the inventor himself) to expose it, and the St
punish and claim arrears, as they would an eva
come-tax. The suggestions put forth have been di
and with me maintain their reasonableness. I sh
glad of any better method to attain the object in v
reduce the number of expensive patent cases. A
ing for trespassing on your space,—I am, &c.,

CHAS. H

CHEMICAL NOTICES FROM FOR
SOURCES.

NOTE.—All degrees of temperature are Centigrade unless o
expressed.

*Comptes Rendus Hebdomadaires des Seances, de l'Ac
des Sciences.* Vol. ciii., No. 3, July 19, 1886.

**Displacement of Ammonia by Other Bases
its Determination.**—MM. Berthelot and André
author's experiments prove the difficulty and tend
of displacing ammonia in its double salts. They
that magnesia, and in certain cases even lime, is inca
of entirely displacing ammonia in the cold or eve
boiling for some hours. Salts which have undergo
action of magnesia, if further treated with dilute h
soda, retain a notable proportion of their ammonia,
can be entirely eliminated only by the action of soda
at a red-heat. Calcium hydroxide itself at 100° a
prolonged boiling only expels a part of the ammo
ammonium-magnesium phosphate. In the cold the a
of lime is prolonged indefinitely in presence of this
Soda alone is quite effective at 100° in presence of
nesium salts, though much more slowly than with am
nium chloride. In the cold its action is almost i
minable. Soda mixed previously with magnesia
with the above-mentioned salts almost like pure
But if magnesia is first used alone soda remains
to complete its action. These circumstances m

aken into account in the analysis of soils, &c., containing organic matters along with phosphates or magnesia.

Variations of the Absorption Spectra in Non-isotropic Media.—H. Becquerel.—Not susceptible of useful abstraction.

Decomposition of Hydrofluoric Acid by an Electric Current.—H. Moissan.—Already inserted.

Urethane from an Analytical Point of View.—G. Jacquemin.—Experiment proves that 0·10 grm. of urethane dissolved in 10 c.c. of mercury and mixed with an excess of potassa is entirely precipitated by a 10 c.c. of standard solution containing 30·44 grm. mercuric chloride per litre. The end of the process is marked by the distinct appearance of a persistent yellow precipitate of mercuric oxide, preceded by a very faint yellowish tint, which, with a little practice, is easily distinguished. Mercuric nitrate and acetate behave with urethane in presence of potassa like the chloride. These two salts, which precipitate urea at once but throw down urethane only with the assistance of potassa, are, therefore, differential reagents for these two compounds. This method is applicable to the detection of urethane in urine. Normal urine, even when much diluted with water, gives by this reaction a white precipitate which blackens on ebullition. The urethane is, therefore, extracted from a specimen of urine by shaking with ether, giving it at least 300 shakes. After decantation it is repeatedly washed with water. The residue, after evaporating the ether, is taken up in a little water and treated as above. By making use of the standard solution of mercuric chloride the weight of urethane extracted from a given volume of urine may be ascertained. Albumen and the yolk of egg, separated and heated with urethane at 30°, decompose it in a manner analogous to aqueous potassa, but the liberation of ammonia is infinitely less. After a prolonged action there is found neither urea nor urethane.

Action of Certain Organic Chlorides upon Dibenzyl in Presence of Aluminium Chloride.—P. Adam. The action of methylene chloride has yielded fluorene. Methyl chloride yields, under similar circumstances, a great number of derivatives, the study of which the author has not yet completed.

On Normal Propylamines.—C. Vincent.—The author separated the three normal propylenes as obtained by Hofmann's general process. He has described nitrosodipropylamine and dipropylamine, and determined the physical constants of di- and tri-propylamine and of nitrosodipropylamine.

A New Creatinine, Ethyl-amido-aceto-cyamidine, and the Formation of Creatinines and Creatines.—Duvillier.—From the results of these experiments it appears probable that the action of cyanamide upon the diluted acids consists essentially in the formation of creatinines, the formation of creatines occurring only in a small number of cases. It is even probable that the diluted acids derived from the ammonias higher than methylamine, or from more complex bases, will yield only creatinines.

Combination of Stannic Chloride with Hydrochloric Acid.—R. Engel.—The compound obtained by the author is a chlorostannic acid answering in its composition to chloroplatinic acid.

On Potassium Alcoholate.—E. J. Maumené.—The crystalline alcoholate, prepared in an atmosphere of hydrogen, is perfectly colourless, and yields 47 grms. of potassa, fused at redness, to 116 of alcohol.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 3, 1886.

Modification of Sonnenschein's Method for Determining Phosphorus in Iron and Steel.—N. Huss.—This paper will, if practicable, be inserted in full.

On Azotometry and Azotometers.—W. Knop.—An illustrated paper.

Analysis of the Hot Springs of Leuk.—G. Lunge and R. E. Schmidt.—This memoir, which requires the three accompanying illustrations, deals with a subject of little general interest.

Determination of Nitrogen in Coal and Coke.—Sigismund Schmitz.—The method of Dumas, which is very tedious and requires great dexterity, has the disadvantage that coal and coke are burnt imperfectly in an atmosphere of carbonic acid, even at a full white heat. The tension in the glass tube is often so great that it blows out or bursts. The Varrentrap-Will method gives results which are too low in case of coal and quite false in case of coke. The author recommends Kjeldahl's process as modified by Stutzer and Reitman.

Criticism of the Direct Methods for Determining Tartaric Acid in Argols and Lees of Wine.—Dr. A. Bornträger. — A treatise of nearly 40 pages, and not capable of useful abridgment.

Determination of Ferric Oxide in Presence of Alumina.— E. Donath and R. Jeller.— In such determinations the iron is generally determined volumetrically by Marguerite's method and the alumina calculated as difference. This procedure, however, is somewhat tedious, whence the author suggests the following modification:—If ferric oxide is ignited in a covered porcelain crucible along with zinc-powder or very fine zinc filings, there ensues an energetic reaction. The ferric oxide is completely reduced to metallic iron and the black-grey spongy mass, which is found under the white crust of zinc oxide, dissolves in dilute sulphuric acid (1 part to 2 or 3 water), even in the cold, but more readily on heating. In this manner a ferrous solution is quickly obtained, containing all the iron in the ferrous state, and it may be at once, after suitable dilution, titrated with permanganate. In practice the mixture of ferric oxide and alumina, as obtained in the course of an analysis, is ground up in a porcelain crucible with from ½ to 1 volume of zinc powder, covered with a small quantity of fine zinc filings, closed with the lid, and strongly ignited for five to eight minutes. The mass, when cold, is easily removed from the crucible and is placed in a flask. The residues adhering to the crucible and the lid are dissolved off with the dilute sulphuric acid as above mentioned, rinsed into the flask, and the contents of the latter are heated to a boil after a further addition of dilute sulphuric acid, which is effected in from ten to fifteen minutes. As regards the zinc, zinc powder is preferable on account of its more energetic action. It contains, however, traces of iron and other substances capable of reducing permanganate, the quantity of which must be previously determined and deducted. Filings obtained from pure zinc can be freed from a mechanical admixture of iron by means of a powerful magnet. "Zincum pulveratum purissimum" has been found useless from containing several per cents of tin. As alumina and chromium oxide are not reduced by ignition with zinc the behaviour of ferric oxide may also be used for the gravimetric separation of these bodies, analogous to Rivot's method. The author remarks in a note that the attempts to render chrome iron more easily soluble in acids by ignition with zinc powder gave negative results.

Improvements in Combustion Furnaces.— Julius Schober.—This paper requires the three accompanying cuts.

Apparatus for Washing and Drying Precipitates with the Most Complete Exclusion of Carbonic Acid and Air.—Ad. Jolles.

Apparatus for the Volumetric Determination of Nitrogen.—Ad. Sonnenschein.

Desiccation of Fats.—Ad. Sonnenschein. — These three papers cannot dispense with the accompanying illustrations.

Normal Volumetric Solutions and the Retention of Mohr's System.—B. Tollens.—The writer protests against Winckler's proposal to double the strength of normal solutions as calculated to produce confusion.

Kipp-Wartha's Sulphuretted Hydrogen Apparatus.—J. Meister.—The author points out that the glass cock connecting this, the upper vessel, with the space where the gas is liberated easily gets out of order, and he proposes certain improvements.

Application of Metallic Hydrogen in Analytical Chemistry.—Schwarzenbach and L. Kritschewsky.—By metallic hydrogen the authors understand such as has been absorbed by palladium. Proceeding from the observation of Graham that such hydrogen possesses a remarkable reductive power, they have examined in how far it may be used for analytical purposes. They found by preliminary experiments that by this means silver, mercury, gold, platinum, palladium, and copper can be thrown down in the metallic state. Manganese in the form of permanganic acid is reduced in presence of free acid to a manganous salt, ferric to ferrous salts, chromic acid to chromium oxide. Potassium chlorate is transformed into the corresponding hypochlorite, acetic acid into alcohol and aldehyd, nitrobenzol into aniline. The salts of lead, bismuth, cadmium, arsenic, antimony, tungsten, molybdenum, zinc, cobalt, nickel, aluminium, cerium, uranium, rubidium, cæsium, as well as of the other alkalies and alkaline earths, are not reduced. The authors used a thin rolled plate of palladium or a wire weighing 3 to 4 grms., saturated with hydrogen by the galvanic process. It is carefully washed and dried and is placed in a very dilute aqueous solution of the salt to be decomposed.

On Fractionated Distillation.—Improved processes have been proposed by E. Claudon (*Soc. Chimique de Paris*), D. Mendeleeff (*Ber. Deutsch. Chem. Gesellsch.*), F. Rasinski (*Journal für Prakt. Chemie*), and Lazarus (*Ber. Deutsch. Chem. Gesellsch.*).

Opening up Silicates by Means of Alkaline Carbonates.—Fr. Stolba.—The silicate is mixed in the usual manner with four parts of sodium carbonate and ignited until it undergoes no further change. The ignited mass is then covered with ½ to 1 vol. of sodium chloride, which has previously been allowed to decrepitate, and heated in the covered platinum crucible until it flows quietly. As soon as the contents of the crucible have become a thin liquid they are poured out upon any suitable slab, and when cold enough they are boiled in water. The mass quickly dissolves and is then subjected to further treatment as usual.

Spectroscopes.—H. Kruss and K. W. Zenger have proposed improvements in these instruments. Zenger dispenses with the slit and the collimator lens and uses in their stead a vertical cylindrical mirror.

Polarising Apparatus.—Th. and A. Dubosq and also C. Reichert have proposed modifications in this apparatus, and which are here figured.

A Lamp for the Production of the Sodium Flame.—H. Landolt.—For a description of the proposed arrangement the reader is referred to the original.

A Rotatory Microscope Stage Capable of being Simultaneously Heated.—R. Schulze.—This apparatus cannot be intelligibly described without the illustration.

Thermo-regulators, Thermostates, and Pressure-regulators.—A series of appliances are here described and figured.

Apparatus for Extracting Liquids with Volatile Solvents.—G. Neumann.

Apparatus for Extracting Solids.—Th. Weyl.—Both these papers require the accompanying illustrations.

Modification of Glaser's Combustion-Furnace.—R. Anschütz and A. Glaser.—The lower part of the side-walls is composed not of clay, but of mica. The set of burners in the new furnace slides in a grove and can be drawn out if needful. This arrangement not merely facilitates repairs but renders it possible to expose every part of the combustion tube to the full action of the flames. This modification is especially adapted for Kopfer's method of elementary analysis.

Modification of the Will-Varrentrap Bulb Apparatus.—C. Arnold.—The construction of this apparatus is shown in the accompanying figure.

Aerostatic Balance for Determining the Specific Gravity of Gases.—E. Lommel.—This instrument depends on the same principle as the ordinary hydrostatic balances and consists of a balance to one end of which a hollow glass globe of known weight is suspended by a fine wire. The latter passes through a fine aperture in the lid of a glass cylinder within which is the glass globe. The cylinder can be filled with different gases through lateral apertures.

Vacuum-Exsiccator with Arrangements for Heating.—R. Anschütz.—From *Liebig's Annalen*.

Pressure-Bottle for Determining Starch.—H. Rempel.—The large frame-work of Lintner's original bottle is suppressed and the arrangement for securing the pressure-plate is fixed only to the neck. Instead of the paraffin-bath he uses an air-bath.

A Gas Generator.—R. Schulze.—This apparatus which cannot be intelligibly described without the accompanying figure, is calculated to produce a constant stream of gas from powdery materials.

Filter of Asbestos Paper.—A. Convert.—The author recommends this paper for many purposes. In many cases it is well to shake up the turbid liquid with fragments of asbestos-paper and then to pour it through an asbestos filter.

Arsenical Chloride of Lime and Potassium Chlorate.—L. Garnier.—Noticed under *Journal de Pharmacie et de Chimie*.

Production of Hydrogen Sulphide free from Arsenic.—Otto v. d. Pfordten.—The author generates the gas by the action of hydrochloric acid upon ordinary iron sulphide, passes it over a desiccating agent, and then into a tube 30 centimetres in length filled with unbroken pieces of potassium sulphide and placed in an air-bath at 350°, and finally through a washing-bottle containing solution of soda. F. Gerhard utilises the process of obtaining hydrogen sulphide by heating magnesium hydrosulphite, first proposed by Divers and Shimidzu. He obtains the magnesium hydrosulphide by the double decomposition of alkaline sulphides or hydrosulphides, or calcium sulphide with magnesium salts. The entire mixture is gently heated, and yields an equable current of gas easily regulated. H. Hager, in order to obtain hydrogen sulphide free from arsenic, uses pure zinc sulphide and hydrochloric acid. The zinc sulphide is obtained by boiling corresponding quantities of zinc oxide or zinc sulphate and sulphur with an excess of soda-lye. The liquid is poured off, the damp mass is mixed with 1-10th of its bulk of white bole and moulded into small rods which are preserved for use. A gentle heat must be applied if a rapid current of sulphuretted hydrogen is required.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sulphide of Molybdennm.—Will anyone oblige me with the title of a most comprehensive work published on sulphide of molybdenum and its compounds.—J. A. M.

THE CHEMICAL NEWS.

Vol. LIV. No. 1394.

ON SILVER CARBONATE.

BY GEORGE STILLINGFLEET JOHNSON.

This compound, as obtained by precipitation of solution of silver nitrate by an alkaline carbonate, is white at first, but becomes yellow when the soluble salts are washed out (Berzelius). According to H. Rose (*Ann. Chem. Pharm.*, lxxxiv., 202), silver carbonate loses carbonic anhydride at 200° C., leaving pure oxide of silver, which begins to evolve oxygen when the temperature is further raised to 250° C.

In "Phillips's Mineralogy," 1852, the mineral *Selbite* is mentioned as a native carbonate of silver, having the composition—

"Carbonic acid	12·0
Silver	72·5
Carbonates of oxides of Sb with Cu..	15·5
	100·0"

Found at St. Wengel's mine in the Black Forest, and in Mexico. Dana also mentions it as a rare mineral. It is described as amorphous, earthy, opaque, and grey.

If the above represents—as I believe it does—the present state of our knowledge regarding this compound, the following observations which I have recently made respecting it cannot be wanting in interest or importance.

Having occasion for some pure silver oxide, I poured a hot solution of silver nitrate into a hot concentrated solution of potassic hydrate (prepared by alcohol), and washed the heavy brown precipitate by decantation many times with boiling water.

The greater part of the pure silver oxide thus prepared was consumed to remove chlorine from an organic solution, but a portion of it was left in the beaker in which it had been precipitated, covered with distilled water, whilst the mouth of the beaker was closed only by a loosely-fitting dial-glass to exclude dust.

After about two months, during which time the beaker and its contents had remained undisturbed, the water with the precipitate was poured off into another vessel, when the bottom of the beaker was found covered with large glistening yellow crystals,* which were detached carefully and separated as completely as possible from the unaltered silver oxide.

On treating a portion of the crystalline matter with diluted nitric acid, it dissolved immediately with abundant effervescence, whilst the solution gave a curdy white precipitate with hydrochloric acid. When laid upon moistened reddened litmus-paper, the crystals showed an alkaline reaction, which disappeared on drying. When heated in a glass tube, the crystals first became purplish-black, then fused at a little below a red heat, and immediately afterwards evolved abundance of gas, leaving a white mass of pure metallic silver, which when soaked with water did not impart the slightest alkaline reaction to that liquid, so that the yellow crystals are thus proved to have been quite free from any carbonate of an alkali metal. 0·090 grm. of the crystals left 0·070 grm. of metallic silver, corresponding with 77·78 per cent of Ag. The formula Ag_2CO_3 requires 78·26 per cent of Ag. The yellow crystals appear, therefore, to be silver carbonate. Examined under an inch object-glass, their form seemed to be prismatic with a tendency to tabular arrangement (thin plates). Next to the crystalline form of this compound, its most striking property is its *fusibility*, and I was the more surprised at this, as neither Berzelius nor H. Rose (*loc. cit.*) makes any mention of it; and, indeed, the statement of Rose that silver carbonate decomposes at 200° C., leaving pure silver oxide, is quite contrary to my own observations. To settle this point—the action of heat upon silver carbonate—I next prepared some of the compound by precipitation of silver nitrate with sodium carbonate and thorough washing by decantation.

Examined under the microscope, the precipitate was quite amorphous. As regards colour, the statements of Berzelius are quite correct. It is first white, and becomes yellow on washing.

Heated in a glass tube, the precipitated carbonate behaved exactly like the crystalline compound; it fused at a little below a red heat, having given off no gas previously, but only undergoing a darkening of colour, and immediately after fusion it tumultuously decomposed, leaving metallic silver. Some of the dry precipitated silver carbonate was heated in a glass tube in a oil-bath with a mercurial thermometer immersed in the oil. The temperature was raised to 350° C., but though carefully watched the whole time, no change was observed, except a darkening of colour, and when subsequently heated over a flame as before, the carbonate fused and behaved as usual. I would, therefore, modify the statement of H. Rose regarding the action of heat upon silver carbonate—thus, it fuses at a low red heat, and is shortly afterwards decomposed tumultuously.

In order, if possible, to throw light upon the mode of formation of the crystalline silver carbonate, the following experiments were conducted.

Some of the pure well-washed precipitated silver carbonate, prepared as above, was suspended in distilled water at the temperature of the laboratory, through which a slow stream of carbon dioxide gas was kept passing for about six hours, the suspended carbonate being frequently stirred up during the passage of the gas. On separating the undissolved carbonate I obtained a colourless brilliant filtrate, which hardly produced any change in the colour of blue litmus-paper. On boiling a portion of this solution a yellowish precipitate of silver carbonate was thrown down. Hydrochloric acid, of course, precipitated silver chloride. 500 c.c. of the filtered solution of silver bicarbonate, prepared as above, was precipitated by HCl, and the weight of silver chloride formed was estimated as usual.

0·440 grm. of AgCl was obtained, which corresponds with 0·423 grm. of Ag_2CO_3.

From this it follows that a litre of water saturated with carbon dioxide gas at about 15° C. will dissolve 0·846 grm. of pure precipitated silver carbonate.

It is interesting here to remark that, according to Lassaigne (*J. Chim. Méd.*, 1848, p. 312), water saturated with carbon dioxide at 10° C. dissolves $\frac{1}{1000}$th of its weight of *calcium carbonate*, which is equivalent to 0·8802 grm. $CaCO_3$ per litre, so that, by a curious coincidence, the actual weights of silver and calcium carbonates, dissolved by water saturated with carbon dioxide gas, are nearly identical.

A portion of the solution of silver bicarbonate was left exposed to the air at the ordinary temperature for 12 hours, after which a little yellowish precipitate was found in suspension. Examined under a ¼ inch object-glass, this precipitate was seen to be crystalline and quite homogeneous, the crystals having exactly the form and appearance observed in the case of the larger ones produced by the gradual carbonation of silver oxide suspended in water exposed to common air.

It is possible that the solution of silver bicarbonate might be useful in medicine as a mild preparation of silver, less likely to produce local irritation when exhibited internally than the nitrate.

In the fusibility and alkalinity of its *carbonate*, silver resembles the alkali-metals; whilst the greater solubility of its *bicarbonate* reminds us of the alkaline earths.

King's College, London, August 2, 1886.

* Roscoe and Schorlemmer, in their "Treatise on Chemistry" (vol. ii., Metals, Part 1, p. 379), mention that "when a mixture of ammonio-nitrate of silver and potassium hydrate is exposed to the air, silver oxide separates out, and after a time lemon-yellow needles of the carbonate."

ON RADIANT MATTER SPECTROSCOPY.*

Part II.—Samarium.

By WILLIAM CROOKES, F.R.S.

(Concluded from p. 66).

The Delicacy of the Spectrum Test for Samarium.

156. The foregoing observations had prepared me for the exceeding delicacy of this spectroscopic test for samarium. Experiments were now commenced with the object of getting some approach to a quantitative estimate of how small a quantity of samarium could be detected.

A solution of specially purified calcic nitrate (79), which was found to contain neither yttrium nor samarium by the radiant-matter test, was standardised, so that 1 part of calcium was contained in 50 parts of solution.

157. A standard solution of samaric nitrate was made containing 1 part of samarium in 100,000 parts of solution.

These solutions were mixed in the proportion of 1 part of samarium to 100 parts of calcium. The spectrum (Fig. 15) was very brilliant, and but little inferior in sharpness to the spectrum given by a 50 per cent mixture.

158. A mixture was now prepared containing 1 part of samarium to 1000 parts of calcium. Very little difference could be detected between the spectrum of this mixture and that of the last. The bands were, however, a little less sharp. Fig. 16 shows the appearance of this spectrum.

159. A mixture containing 1 part of samarium to 10,000 parts of calcium. The resulting spectrum is shown in Fig. 17. The bands are now getting fainter, the second green band is fading out, and the continuous spectrum of calcic sulphate is getting brighter.

160. The next mixture tried contained 1 part of samarium in 100,000 parts of calcium. The appearance of the spectrum is shown in Fig. 18. Here the green is almost gone, being overshadowed by the continuous spectrum of calcium which has spread over it. The red band has likewise almost disappeared in the greater brightness of the continuous red of the calcic spectrum. The double orange band is still very prominent, and the black space, 2942, between it and the green is very marked.

Fig. 15.

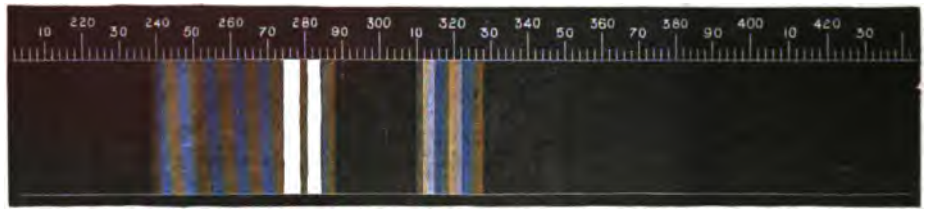


Fig. 16.

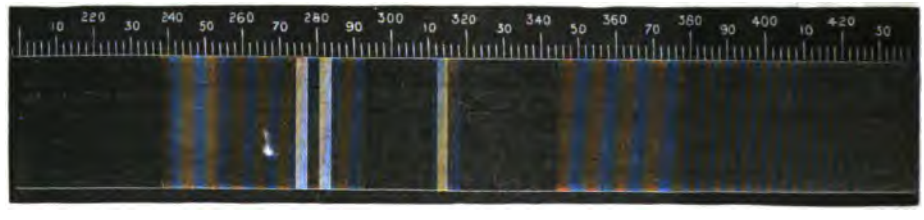


Fig. 17.

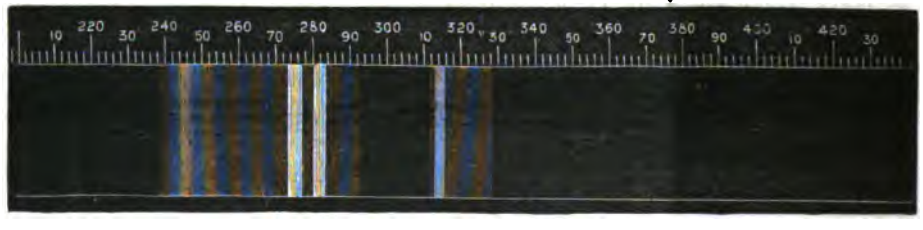
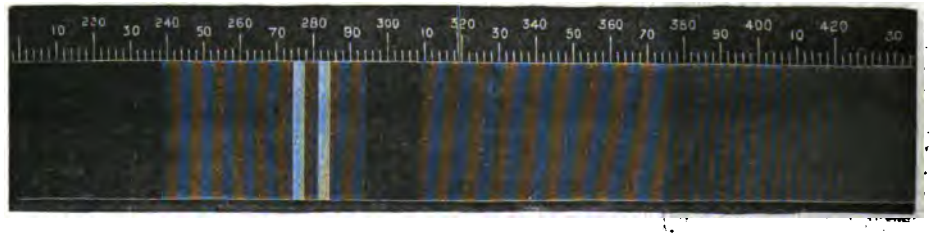


Fig. 18.



* A Paper read before the Royal Society, June 18, 1885.

161. The next mixture, 1 part of samarium to 500,000 parts of calcium, gives a spectrum which is fainter than the last, but the orange bands are still distinctly visible. The black space between the yellow and green is strongly marked, but narrower than before. Fig. 19 shows the appearance of this spectrum.

162. A mixture of 1 part of samarium in 1,000,000 parts of calcium was next subjected to experiment. In this the samarium spectrum is very feeble, and the orange bands are only to be seen with difficulty. Now the most striking characteristic of this spectrum is the black space

164. Finally the calcium spectrum by itself was examined. It is continuous, with no break, lines, or bands in it.

The Anomalous Line $\frac{1}{\lambda^2}$ 2693.

165. On several occasions I have spoken of an orange line, 2693, which by its brilliancy and sharpness is a prominent object in most of the samarium-yttrium spectra. With samaric sulphate it is exceedingly faint. With samaria containing 5 per cent of ytrria it is very little

FIG. 19.

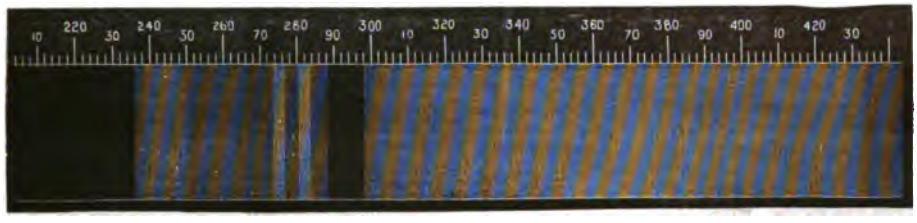


FIG. 20.

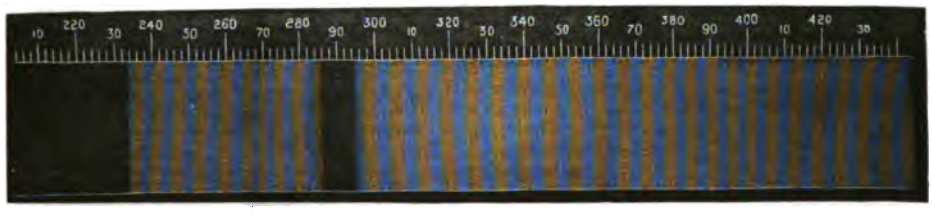


FIG. 21.

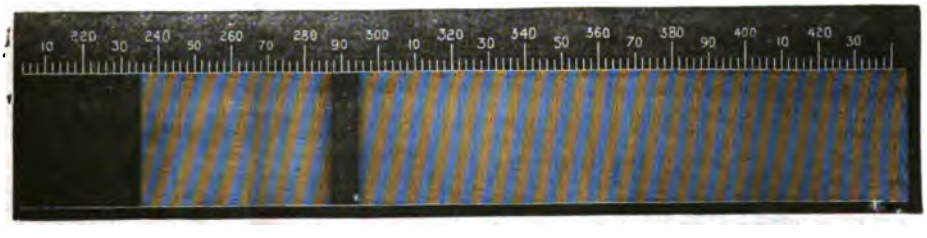
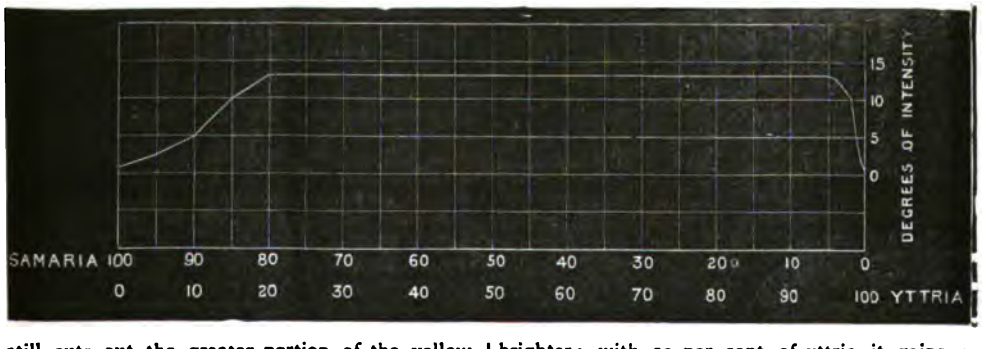


FIG. 22.



which still cuts out the greater portion of the yellow. Fig. 20 represents this spectrum.

163. A mixture of one of samarium in 2,500,000 parts of calcium was now taken. In the spectrum shown by this mixture the bands of samarium have entirely gone, and its presence now is apparent only by the darkening in the yellow portion of what otherwise would be a continuous spectrum. Fig. 21 shows this appearance.

brighter; with 10 per cent of yttria it gains a little; with 15 per cent it is brighter still, and with a mixture of 80 parts samaria and 20 parts yttria it is at its maximum intensity. It continues to be the most striking feature in the spectra of the various mixtures of samaria and yttria until the proportion becomes samaria 3, yttria, 97, when it begins to get less bright, and only when pure yttria is reached does it altogether vanish.

The accompanying diagram (Fig. 22) shows the rise and fall in intensity of this bright line, with the proportions of samaria and yttria experimented on.

166. It is noteworthy that so long as this bright line is a component of the spectrum, the other bands manifest decidedly less intensity than they do in other phosphorescent spectra where this line is absent. Many of the bands usually present in the samaria and yttria spectra are also suppressed. The profound modification in the spectra of samaria and yttria developed by their mixture is, I believe, without precedent in spectrum analysis. The molecules of each earth, samaria and yttria, which separately are capable of vibrating rhythmically and of giving a characteristic phosphorescent spectrum, when mixed yield a spectrum approaching in character that of samaria or of yttria, according as one or other earth preponderates, and produce the dominant line 2693.

167. In this and the former paper on Radiant Matter Spectroscopy much stress has been laid on the sensitiveness of the Radiant Matter test for indicating the presence of samarium and yttrium; but it might be argued, from the anomalies that arise when *both* these elements occur together, that in reality the Radiant Matter test, however delicate, is not one to be depended upon. For instance, it might reasonably be asked what inference is to be drawn in the case of certain minerals treated with sulphuric acid and tested in the vacuum tube, and found to give only a feeble spectrum? Does this prove the absence of all but traces of either samarium or yttrium, or does it show the presence of both these earths in considerable quantity? The answer is simple. In spite of the perplexing anomalies that have come to light, and are described in this paper, regarding the influence of these two phosphorescing earths on each other, no single instance has occurred during the work connected with this subject in which, with the experience now gained, brilliant phosphorescence and a characteristic spectrum could not be evolved from any mixture containing both or either of the earths samaria and yttria. If, after treatment with sulphuric acid and ignition, the earthy mixture gives a pure spectrum of either yttria or samaria, and the line 2693 is absent, it is pretty safe to assume that the particular earth indicated is alone present. If, however, the spectrum is not quite characteristic, or the anomalous line 2693 is present, it is not sufficient to test the unknown mineral or mixture direct in the vacuum tube. It must first be treated chemically to separate the samaria and yttria (123, 133), and lime must be added before testing in the radiant-matter tube (138), when the spectrum immediately makes its appearance if either of these earths be present in the smallest quantity. Although I say lime is to be added, many other substances perform the same office of eliciting the spectrum, such as baryta, lead, &c. (142—145); but my chief experience has been with lime, and I have always found it to give uniform results under varied conditions.

One important lesson taught by the many anomalies unearthed in these researches is, that inferences drawn from spectrum analysis *per se* are liable to grave doubt, unless at every step the spectroscopist goes hand in hand with the chemist. Spectroscopy may give valuable indications, but chemistry must after all be the court of final appeal.

168. Chemistry, however, by itself would have been helpless to solve the difficulties had it not been possible to appeal at every step to the radiant-matter tube and to the spectroscope. The problems to be solved are so new as to be entirely outside the experience of laboratory work. A double orange-coloured band shows itself in a faint emission spectrum obtained under novel circumstances. On further examination the band, or one not far from it, is seen to occur in minerals of very divergent kinds, and apparently irrespective of their chemical constitution or locality, as well as in laboratory reagents and chemicals of assured purity. This band is sometimes accompanied by bands in other parts of the spectrum, and occasionally shifts its place to the right or to the left. Frequently the orange band disappears and a citron-coloured band takes its place. Chemical research continued for a longer time than most chemical researches require fails to throw any light on the subject. These being the conditions of the problem, the very last explanation likely to occur to the enquirer would be that these elusive shifting bands were due to the presence of two elements almost universally distributed, and that these two elements should be yttrium and samarium,—yttrium one of the rarest of known elements, and samarium almost unknown at the time its spectrum reaction was first discerned.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 66.)

IV. *Analysis of Chlorate of Silver*, β 209.

Chlorate of Silver.	Chloride of Silver.	$AgClO_3$: AgCl=100.	Molecular weight of the Chloride of Silver.
138·789 grms.	103·9795 grms.	74·9191 *m*	143·3808*
259·5287 „	194·4435 „	74·9218 M	143·4011*
	Mean,	74·92045	143·39095
	Log. =	1·8746003	2·1565218

If p grms. of chlorate of silver gives q grms. of chloride of silver the molecular weight is:—

$$AgCl = 48\frac{q}{p-q}$$

The same remark applies to tables VI., VIII., and IX.

V. *Synthesis of Bromide of Silver*, β 158, 171.

Silver.	Bromide of Silver.	Ag : AgBr=100.	
53·1958 grms.	92·6042	174·0817*	Synthesis by diff.
51·3436 „	89·3780	174·0782* *m*	Complete syntheses.
55·0615 „	95·8505	174·0790*	
55·8040 „	97·1450	174·0825*	
48·3620 „	84·1904	174·0836* M	
	Mean,	174·0810	
	Log. =	2·2407515	

In the last four experiments M. Stas also weighed the bromine; the sum of the weights of the bromine and the silver used was 1 m g. to 10 m.g. higher than the weight of the bromide of silver produced. This follows from the difficulty of freeing bromine of the last traces of humidity. These syntheses by sum are an excellent check, but I have never used them for calculating the mean. M. Stas, on the other hand, only compares the results of the complete syntheses with the conditions necessitated by Prout's hypothesis.

A sixth synthesis is closely related to the 9th determination of the relationship between silver and bromide of potassium, Table VIII.

VI. *Analyses of Bromate of Silver*, β 200.

Bromate of Silver.	Bromide of Silver.	$AgBrO_3$: AgBr=100.	Molecular weight of Bromide of Silver.
86·5457 grms.	68·9310 grms.	79·6469* *m*	187·8368
101·9875 „	81·2361 „	79·6530 M	187·9069
	Mean,	79·6500	187·8718
	Log. =	1·9011856	2·2738617

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.

VII. *Synthesis of Iodide of Silver*, β 135, 152.

Silver. Grms.	Iodide of Silver. Grms.	Sum of the Iodine and Silver used. Grms.	AgI : Ag=100. By the Silver Iodide obtained.	By the weights of Iodine and Silver used.
97·5915	212·2905	Syntheses	217·5297*	—
43·5281	94·6894*	by diff.	217·5362	—
27·6223	60·0860	60·0888	217·5271 *m*	217·5373*
39·8405	86·6653	86·6687	217·5306	217·5392*
24·4649	Not obtained.	53·2201	—	217·5366*
38·0795	82·8375	82·8394	217·5383	217·5433 M
136·3547	296·6240	296·6299	217·5385	217·5429*
82·33735*	179·1080*	179·10745*	217·5294	217·5287*
		Mean,	217·5328	217·5380

Mean of thirteen estimations, 217·5352

Log. = 2·3375295

In the last experiment the figures in M. Stas's table do not agree with the details β 148—150. The weight of silver I used is the first weight, 82·3231 grm., plus that used for precipitating the iodine in the liquid (1098·9 c.c. or 1104·9 c.c.) which remained with the iodide of silver = 0·013 grm. + that used to ensure accuracy = 0·00125 grm. The weight of the iodine is the original weight, 96·7964 grms. + that used to ensure accuracy = 0·0013 grm., *minus* the iodine taken up by the 2019·7 c.c. of liquid = 0·0276* grm.

The oxide of potassium could not hold more than 3 m.g. of water. The water taken up diminishes the molecular weight.

In the *second series* the chlorate was decomposed by hydrochloric acid. The two methods reversing the errors, I consider the mean of the second series as the most probable figure, see *y* 59.

Chlorate of Potash.	Oxygen.	$KClO_3$: 3O = 100.	Molecular Weight of Chloride of Potassium.
69·8730 grms.	27·3636 grms.	39·1619 M	74·5681 *m*
82·1260 ,,	32·1612 ,,	39·1608*	74·5716
86·5010 ,,	33·8706* ,,	39·1563*	74·5856
132·9230 ,,	52·0426* ,,	39·1524*	74·5977
127·2125 ,,	49·8102 ,,	39·1551	74·5893
59·727 ,,	23·3830 ,,	39·1498	74·6060
95·7975 ,,	37·5020 ,,	39·1472 *m*	74·6143 M
147·318 ,,	57·6840 ,,	39·1561	74·5862
Mean of eight estimations =		39·1549*	74·5898
Log. =		1·5927861	1·8726794
Mean of the 2nd series =		39·1510	74·6022
Log. =		1·5927429	1·8727517

(To be continued).

Iodate of Silver.	Iodide of Silver.	Oxygen.	$AgIO_3$: AgI = 100 after the weights of Iodide of Silver.	Molecular weights of Iodide of Silver according to the weights of the Iodide used.	Molecular weights of Iodide of Silver according to the weights of the oxygen set free.
98·2681 grms.	81·5880 grms.	16·6815*	83·0259*	234·7842*	234·7645
156·7859 ,,	130·1755 ,,	26·6084	83·0276 M	234·8114	234·8290
76·5561 ,,	63·5600 ,,	Synthesis by diff.	83·0241 *m*	234·7535*	—
		Mean =	83·0259	234·7830	234·79675
		Log. =	1·9192136		

Mean of five estimations, 234·7885

Log. = 2·3706768

IX. *Analysis of Chlorate of Potassium*, α 320, 321.

In the *first series* the chlorate was decomposed by heat. A small portion is decomposed according to the equation—

$$2KClO_3 = K_2O + Cl_2 + 5O.$$

Instead of one atom of oxygen = 16, two atoms of chlorine = 70·912 are set free. The loss of weight of the chlorate is thus too great in the relation of 54·912 to 70·912 of chlorine set free. This chlorine was absorbed in a tube containing finely divided silver heated to a dull red colour.*

For the five experiments the weight of this chlorine reached—

7·5 m.g. 11·0 m.g. 2·5 m.g. 8·5 m.g. and 3·6 m.g.

It was therefore necessary to reduce the apparent weight of the oxygen.

5·81* m.g. 8·52 m.g. 1·94* m.g. 6·58* m.g. and 2·79 m.g.

M. Stas believes that traces of chlorine were still carried over without uniting with the silver.

The chlorate of potash contained at least 5·100000 of silica (α 258, 309; β 233), which causes the molecular weight of the chloride of potassium to be put too high. On the other hand, a very small quantity of water was given off by the sulphuric acid tubes (not more than 4 m.g.).

* According to M. Schützenberger oxygen has the power, *in the cold*, of putting chlorine into a mysterious state so that it will not precipitate the salts of silver (*Comptes Rendus de l'Académie des Sciences*, xcviii., p. 1520, 1884.

ON THE PREPARATION OF TRICHLORMETHYL-SULPHONIC CHLORIDE.

By H. BASSETT.

Having had occasion to prepare some of this substance, after making trial of the method of Berzelius and Marcet, its discoverers, and also of that recommended by Kolbe, I devised the following process, which is most satisfactory from its facility and economy.

Take potassium chlorate in powder 100 grms., add to this, in a flask, a mixture of 200 c.c. common hydrochloric acid and 400 c.c. water, and then 50 c.c. bisulphide of carbon, and leave the flask loosely covered with a small inverted beaker, preferably outside a window in a good light. In an hour or so the action commences; the liquid turns yellow, and minute bubbles of gas disengage themselves from the bisulphide of carbon. Strong sunlight may cause the flask to become hot, in which case the reaction becomes too violent, and must be moderated by cooling under the tap. In the heat of summer the proportion of water should be increased, but in frosty weather with no sun equal volumes of acid and water may be used.

The action goes on without requiring any particular attention beyond occasional agitation till finished, which may take from three days to a fortnight, according to the light, &c. The completion of the action is well

marked; the chlorate is completely dissolved in the clear yellow solution; the bisulphide, which has gradually become thick and pasty, is converted into the white solid product, and the evolution of gas which has continued throughout the reaction completely ceases. It is then only necessary to pour off the strongly acid liquid, wash well with water, after crushing the peculiarly tough lumps in a mortar, and then wash thoroughly free from acid on a linen filter. The mass is then squeezed as dry as possible in the cloth, broken or crumbled up, and dried over sulphuric acid till it ceases to lose weight.

Two reactions appear to go on together, one portion of the bisulphide being entirely converted into carbonic and sulphuric acids, and the yield of trichlormethylsulphonic chloride varies in different experiments, being greater when the action is slower, from cold weather, &c. I have obtained 43 grms. as a maximum from 50 c.c. bisulphide of carbon.

The product obtained as above is quite white and clean, and when sublimed leaves only a very small residue of impurities. The bottles containing it become after a time coated with very beautiful lustrous transparent crystals, having the melting-point, 135°, attributed to the pure substance.

NEW EXPERIMENTS ON THE DECOMPOSITION OF HYDROFLUORIC ACID BY AN ELECTRICAL CURRENT.

By H. MOISSAN.

In decomposing, by an electric current, hydrofluoric acid rendered conductive by means of a hydrofluoride of potassium fluoride, we obtain at the positive pole a gaseous body having very energetic properties, and which, according to former researches, must be either fluorine or hydrogen perfluoride.

The author now indicates a new process for preparing this gas, founded on the electrolysis of the hydrofluoride of potassium fluoride, carefully dried and kept in fusion at the temperature of 110°. The experiment is made in the apparatus formerly described. The melted hydrofluoride swells up much under the action of the current, a portion escapes by the abductor-tubes, and at this temperature of 110° the platinum was so strongly attacked that the experiment could not be continued. If platinum wires conveying the current of ten Bunsen elements are plunged to the hydrofluoride kept in a liquid state in a platinum capsule, gases are evolved in abundance at each pole, and when they come in contact they produce—even in the dark—a slight detonation. The platinum wires are corroded in a few moments.

It must be added that in the electrolysis of hydrofluoric acid there may be obtained at each pole a yield of 1½ to 2 litres per hour, whilst the experiment may easily be continued for three hours if we employ a sufficient quantity of hydrofluoric acid. Is the gas thus obtained a compound of hydrogen and of fluorine more highly fluorised than hydrofluoric acid? Are we not in presence of hydrogen perfluoride? To answer this question it is sufficient to show that the gas thus obtained contains no hydrogen. This may be done by passing the gas over iron kept at a red-heat. In case of fluorine the gas should be entirely absorbed; if, on the contrary, we have obtained a compound of fluorine and hydrogen, this latter gas will be set at liberty, and might be collected in an atmosphere of carbonic acid, from which it may be easily freed by means of a solution of potassa.

The experiment was arranged as follows:—At the end of the platinum tube at which the active gas is liberated is placed a tube of the same metal, one-fifth of a metre in length, filled with fragments of potassium fluoride absolutely dry. This compound retains very well the vapours of hydrofluoric acid which escape simultaneously. A potash tube of the same length adjusted to the former contains a bundle of iron wires, and has been tared before the experiment. To this last metallic tube is connected, by means of a caoutchouc joint, a large test-tube, and then a bottle, both inverted and filled with pure carbonic acid. This part of the apparatus was traversed before the experiment by a rapid current of pure, dry, carbonic acid. The gas escaping was analysed: 100 c.c., after absorption by carbon dioxide, left merely a very small bubble of air, the volume of which was unimportant. On the hydrogen side were arranged a test-tube and a 1-litre bottle, connected by bent tubes and likewise full of pure carbonic acid. The extremity of each apparatus is in communication with the air by means of a caoutchouc tube, 2 metres in length, the open end of which is raised and placed above the level of the carbonic acid in the bottles. By this arrangement it was possible to collect separately and without pressure the gases escaping from the platinum apparatus, both at the negative and the positive poles. After all these precautions were taken the current of twenty Bunsen elements was passed into the hydrofluoric acid, which was surrounded by methyl chloride and cooled to −50 by a rapid current of air. The platinum tube containing the iron is heated at once to dull redness, and there can be remarked the form of the iron wires burning in the gas. The electrolytic decomposition is allowed to go on for ten minutes, replacing the methyl-chloride if requisite. The experiment is then stopped, the apparatus taken down, and the tube containing the iron fluoride is weighed. It is found as a crystalline fluoride, of a white colour, slightly greenish, at the end of the iron wires; there is also a small quantity of platinum fluoride. The apparatus filled with carbonic acid is transferred to a water-trough, and slowly absorbed by a solution of potassa. The remaining gas is measured and analysed. The weight of the iron was increased by 0·130 grm.; the gas coming from the negative pole contained 78 c.c. of hydrogen, burning with a pale flame without detonation. The active gas, deprived of hydrofluoric acid by means of potassium fluoride, had thus been entirely absorbed by iron raised to dull redness, yielding a weight of iron fluoride sensibly corresponding to the weight of the hydrogen liberated. The gas which electrolysis liberates from anhydrous hydrofluoric acid, or from the hydrofluorised fluoride, is therefore fluorine.—*Comptes Rendus*, ciii., p. 256.

ON THE DETERMINATION OF ABSOLUTE NEUTRALITY.

By J. R. DUGGAN.

(Concluded from page 69).

If, now, formic acid is used instead of acetic, a similar series is obtained, except that the retardation from the normal salt is not so great, and the excess of acid required to prevent retardation is considerably less. With propionic acid the reverse is the case, the retardation from the normal salt being greater, and more than two equivalents of acid to one of base being necessary to prevent retardation. It is evident from this that in sodium formate the alkali is more nearly neutralised than in the acetate, while it is less so in the propionate. It will be seen from this that this reaction can be utilised to determine the power that different acids have for neutralising an alkali. Instead of determining the excess of acid which was necessary to neutralise the normal salt, it was found that more accurate results could be obtained, without affecting the proportion, by finding the amount required to retard the reaction 50 per cent. As a standard for comparison a flask containing five equivalents of acetic to one of sodium acetate was used, instead of one containing only diastase and starch. This retarded about 50 per cent, but as

it was desirable simply to compare the acids among themselves, the actual degree of retardation was of little importance. The amounts of various acids in excess of the one equivalent which combined with the caustic soda to form the normal salt, which were necessary to produce the same retardation as the five equivalents of acetic, are given in the first column of Table III. They are for convenience expressed in their caustic soda equivalents in the second column. The figures are the amounts required with 20 m.grms. of caustic soda, as this was the amount generally used, but in some of the series 40 m.grms. were used. The results are the mean of several series.

TABLE III.

Acid.	Required amount.	NaOH Equivalent.
Formic	14·4 m.grms.	12·5 m.grms.
Acetic	150	100
Propionic	246	133
Isobutyric	273	124
Lactic	27·0	12·0
Benzoic	82·4	27·0
Phenylacetic ..	129	38·0
Oxalic	6·30	5·60
Succinic	109	74·0
Pyrotartaric ..	99·0	60·0
Malic	38·5	23·0
Tartaric	18·4	9·80
Fumaric	18·3	12·6
Phthalic 1 : 2 ..	42·5	20·5
Citric	46·4	29·0

These figures represent the amount of each acid necessary to produce a certain degree of acidity in a solution which contains the amount of salt formed by the combination of the acid with 20 m.grms. of caustic soda. Of course the affinity of each of the acids is less than that of caustic soda. If acids having a coefficient of affinity greater than that of the base were used, it would then become necessary to use a certain amount of some alkali to prevent the retardation caused by the normal salt, since it would be acid. This part of the subject has not yet been investigated, except to a very slight extent.

The neutralisation of an alkaline base by an acid of lower affinity may be divided into two stages—the saturation of the base to form a normal salt and the neutralisation of the alkaline salt. The amount of acid necessary to accomplish the first of these depends, of course, upon its combining weight and the number of replaceable hydrogen atoms it contains. In order to determine if the amount required in the second stage depends upon the affinity of the acid, the following experiments were made. Since, according to Ostwald,* the power which an acid shows in inverting cane-sugar is the most reliable measure of its affinity, I determined the amount of each of the acids that is required to convert a given amount of cane-sugar under fixed conditions. 10 c.c. of a 20 per cent solution of cane-sugar was, in each case, made up to 50 c.c. by the addition of the acid and water. The solutions were heated to 70° C. before mixing, and kept in a water-bath at this temperature for thirty minutes. The reaction was stopped by the addition of a slight excess of caustic soda, and the sugar determined by Fehling's solution as dextrose. The standard for comparison was in each case a flask containing the above amount of sugar and 0·150 grm. of acetic acid. By using this as a control experiment, any slight variation in time or temperature caused no error, as all the flasks were under the same conditions. The first column in Table IV. shows the amount of each acid required to produce the same amount of conversion as 0·150 grm. of acetic. In the second column the acids are expressed in their soda equivalents, while the third is a repetition, for comparison, of the second column of Table III. The fourth column gives the percentage proportion between the figures in the second and third columns, those in the second being taken as 100.

* *Loc. cit.*

TABLE IV.

Acid.	Inversion of Cane-sugar. Required amount. M.grms.	Inversion of Cane-sugar. NaOH equiv. M.grms.	NaOH equiv. of amount required to neutralise the normal salt. M.grms.	Per cent proportion.
Monobasic.				
Formic	13·8	12·0	12·5	104
Acetic	150	100	100	100
Propionic	255	138	133	96·4
Isobutyric	286	130	124	95·4
Lactic	26·1	11·6	12·0	103
Benzoic	85·0	27·9	27·0	96·4
Phenylacetic ..	125	37·3	38·0	102
Dibasic.				
Oxalic	3·71	3·30	5·60	169
Succinic	66·4	45·0	74·0	164
Pyrotartaric ..	57·8	35·0	60·0	171
Malic	20·8	12·4	23·0	(185)
Tartaric	10·9	5·80	9·80	169
Fumaric	10·9	7·50	12·6	163
Phthalic 1 : 2 ..	11·6	5·60	20·5	366
Tribasic.				
Citric	15·7	9·80	29·0	296

It is evident from this table that the amount of a monobasic acid required to neutralise an alkaline salt of that acid is proportional to its affinity as measured by its action on cane-sugar. Spohr has reached practically the same conclusion from his study of the influence of normal salts on the inversion of cane-sugar by acids.* In the case of dibasic acids the table shows that more is required to neutralise the salt than with monobasic acids, or that the normal salt is more alkaline than it would be if formed from a monobasic acid of the same affinity constant. For example, it was found that normal sodium succinate retards the action of diastase more than an equivalent quantity of sodium acetate, although succinic acid inverts sugar more rapidly than acetic, and might therefore be supposed to form a less alkaline salt. It must be remembered that in comparing the action of acids, the carboxyl groups are compared, so that half an equivalent is used in the case of dibasic acids. To explain this greater alkalinity of salts of dibasic acids, we must suppose that each atom of sodium not only neutralises the carboxyl group into which it enters, but influences in some manner the other similar group in the molecule. There is reason to suppose that a molecule of oxalic acid inverts cane-sugar more rapidly than would two molecules of an acid having the formula COOH, or that the affinity of polybasic acids is increased by a mutual reaction between the carboxyl groups.† This being true, it follows that the neutralisation of one carboxyl group in such an acid must diminish the affinity of the remaining ones. In the case of phthalic acid this action is much more marked than with acids of the paraffin series. This cannot be due to experimental error, as this acid was examined very carefully; but it will be necessary to examine other acids in which we have what is termed the ring structure before attempting any explanation of this. In the case of the one tribasic acid examined, the amount of acid required to neutralise the salt is, as would be supposed, more than with either mono- or dibasic. As all of these results were obtained from the use of a monacid base, it does not follow that they would hold good for a polyacid base.

The greater alkalinity af salts of polybasic acids is very well shown in the case of phosphoric acid, for although a molecule of this acid converts sugar more rapidly than three molecules of acetic, it is with considerable difficulty that the acid can be made to form a normal sodium salt. In other words, the acidity of the acid is so well neutralised by one or two atoms of sodium that it is only with

* *Jour. f. prak. Chem.*, (2), xxxii., 46.

† See Muir's *Principles of Chemistry*, p. 470.

difficulty that it can hold a third. The reverse of this tendency of the weaker polybasic acids to form only primary or secondary salts is seen in the frequent formation of basic salts when a strong acid combines with a slightly alkaline base.

The Influence of Alcohols on Diastatic Action.

In the presence of about 7 p.c. by weight of ethyl alcohol the action of diastase is retarded one-half, but if there is added to 100 c.c. of the solution about 3 m.grms. of acetic acid there is but little retardation. That the retardation by the alcohol which is prevented by this minute quantity of acid is due to its alkalinity is borne out by the fact that the inversion of cane-sugar by acids is also retarded by the presence of alcohol. Titration before and after the experiment showed that there was no etherification, as would be supposed, considering the extreme dilution of the acid. it seems natural to conclude from this that there is here a condition similar to a basic salt in which a great many molecules of the base are combined with one of acid, for if such is not the case, it is difficult to explain the action of the acid in neutralising the alcohol. Under these conditions the alcohol shows alkaline, but not basic properties, since it does not unite with the acid to form an ester (salt). This action of alcohols is of considerable physiological interest, and I hope by further study to throw some light on their action on the living organism. As we approach the acid-phenols through the secondary and tertiary alcohols we find that they act less and less on diastase, until phenol is reached, when we get decided action from its acidity. I hope to verify the results I have obtained by a further study of the influence of alcohols an the inversion of cane-sugar by acids, and until that is done, a lengthy discussion including the different alcohols would be premature.

As the value of any method depends to a great extent upon its accuracy, it will be well to notice the experimental errors that show themselves in the above determinations. An examination of the fourth column of Table IV. shows that these may amount to several per cent. Of course, any impurity in the acid is likely to produce an error, and this is probably the cause of the rather larger amount of malic acid required to neutralise the normal salt. In the experiments with diastase there is probably a small amount of the acid used up in combining with the proteid matter and salts which cannot be entirely removed from the starch and diastase solution. It will be seen that rather more of the acids which have a high affinity constant is required than the theory calls for. As they are used in small amounts, any proteid matter present would render inactive a proportionately larger quantity of these than of the weaker acids. Ostwald has shown that the results obtained from the inversion of cane-sugar depend to a slight extent on the concentration of the solutions used. When the errors from these and other causes happen to be all on the same side, it is not surprising that they should amount to several per cent. I think the results obtained, however, show that the method is valuable, and will assist in the important work that Ostwald has undertaken. It cannot be doubted that the physiological action of organic acids is dependent to a great extent on their affinity, and the determination of affinity-constants will probably be of as much value to physiological as to pure chemistry.

In conclusion, I do not think it will be out of place to offer a protest against the custom of calling salts acid or neutral according to whether a part or all of the hydrogen is replaced. Primary or mono-sodium carbonate is not an acid salt, nor is the normal salt neutral. This is an extreme case, but it is taken to show that such a use of these terms is incorrect even if we use only the ordinary colour indicators.

I am under many obligations to Prof. Remsen for suggestions and for advice which he has kindly given me during the progress of the work.—*American Chemical Journal.*

NOTICES OF BOOKS.

The Chemistry of Wheat, Flour, and Bread, and Technology of Bread-Making. By W. Jago, F.C.S., F.I.C.

The chemistry of flour and bread, notwithstanding its obvious importance, is overlooked or but slightly touched upon in technological cyclopædias. Hence there is fair room for the very comprehensive treatise which Mr. Jago here lays before the public. The foundations of the work are, as here stated, a paper on the same subject read before the National Association of British and Irish Millers in 1883, and a course of sixty-four articles which subsequently appeared in the *Millers' Gazette*. These papers have been elaborated into the volume before us.

The author sets out with three chapters on general chemistry. The fourth chapter is devoted to the microscope and the polarisation of light. All these chapters are well written, but it is at least an open question whether the reader might not, for all the information they contain, have been referred to some one or other of the many chemical manuals which are now so plentiful. The only two points in these chapters calling for remark are the use, in one instance, of the unhappy term "metalloids" for the non-metallic elements, and the description of methylated spirit given on p. 39, which is decidedly too favourable. As ordinarily to be bought it contains shellac, and is thus rendered ill-fitted for almost every conceivable operation except the production of varnishes. Even when free from shellac the aldehyd and other impurities present in the raw wood-spirit grievously interfere with its uses both in research and in the chemical arts.

With Chapter 5 begins what may be called the special portion of the work. We have here an account of the carbohydrates and their transformations, of the albumenoids, of fermentation, of the lactic and putrescent fermentations, &c.; the paragraphs on yeast as an organism, on its botanic position, its varieties, and its life-history. The chemical distinctions which the author draws between plants and animals seem to us too absolute. The carnivorous plants, far more numerous than it was long supposed, nourish themselves in part from complex organic matter. Vegetables are also known which in certain phases of their existence normally evolve heat. On the other hand, chlorophyll, with its function of decomposing carbon dioxide, has been traced in the animal world, and among the great group of arthropods synthesis is a prominent function.

In the chapter on the manufacture and strength of yeasts the author fails to show how the terms yeast and barm replace each other in different parts of the kingdom. In Cheshire, Lancashire, and the south-west of Yorkshire, the product derived from the brewery is invariably known as barm. In the South of England and in the more northern parts of Yorkshire, from about Huddersfield onwards, the word "yeast" is universal, and to most of the inhabitants "barm" is unintelligible.

From Chapter 13 the author proceeds to Moulds and Fungoid Growths of the Physical and Chemical Composition of Wheat. Here we find some very valuable tables showing the analysis of the grain from the principal wheat-growing districts. Bread-making is discussed at length. Here the judicious rule is laid down that a water unfit for drinking is also unfit for baking. Living organisms, it is shown, are liable to set up putrefactive fermentations. The sanitary aspects are next considered. These, it is well known, are far from faultless, especially in London. Several kneading-machines are mentioned, and it is much to be desired that bread should be untouched by hand in every stage of its preparation. Baking powders containing potassium bisulphate and alum are deservedly condemned. The use of hydrochloric acid and sodium carbonate for raising bread is objected to, as the acid of commerce generally contains arsenic.

The "bread-reform" movement does not meet with

approbation. It is shown that the retention of bran in the flour irritates the intestine, quickens the peristaltic action, and thus hinders the complete digestion of the albumenoids present.

The remainder of the work deals chiefly with the analysis of wheats, flours, and bread. Here we find that the determination of albumenoids by the ammonia process, as invented by Wanklyn and Chapman, is given at considerable length. Strong exception is taken to the opinion of Wanklyn and Cooper ("Bread Analysis") as to the quantity of water which bread may legitimately contain.

Taking Mr. Jago's work as a whole it deserves a welcome as supplying a distinct want in our technical literature.

Two clerical errors are frequently repeated: phenolphthaleine is printed phenolphthalien, and the name Soxhlet is converted into Soxhlett. A very disagreeable feature is the introduction of two pages of advertisements in the middle of the book,—an innovation which we hope may not find imitators. The work, it must be added, is not published through the trade, and can be obtained only direct from the author.

CORRESPONDENCE.

FUCHSINE—PYROXYLIN—PHYLLOXERA.

To the Editor of the Chemical News.

Sir,—I notice in the Chemical News (vol. liv., p. 46), in a review of Professor Edgar Smith's translation of Von Richter's "Chemistry of the Carbon Compounds," your reviewer protests against the use of the name "fuchsine" as descriptive of the commercial salts of rosaniline, preferring they should be called "magenta," on the ground that "fuchsine" is a name "unpronounceable by every Englishman who is not a German scholar." The same objection to the name fuchsine was made in the review in these pages (July 3rd, 1885) of Vol. I. of my own work on "Commercial Organic Analysis," but I did not then feel justified in making the protest which I can now that the criticism is applied to the work of another writer. It seems to me that the Reviewer's objection to the term "fuchsine" is a mistaken one. The name appears to me eminently applicable to a colouring matter capable of dyeing goods a tint closely resembling that of the flower called a "fuchsia," which word is well-known to every Englishman, and the common pronunciation of it corresponds with that I find attributed to it in Nuttall's "Dictionary," which is "few'-she-a." On the other hand, your reviewer prefers the word "magenta," a name which is not descriptive, and which seems to me less suitable than that of "fuchsine."

While on the subject, I may mention another word which, to my mind, is frequently mispronounced, and that is "pyroxylin." There are no two opinions as to the way in which xylene and para-xylene should be pronounced, and surely pyro-xylin should be treated similarly. Yet how often do we hear chemists, who consider themselves men of light and leading, pronounce pyroxylin in a manner parallel to hydroxyl. Are they right, or am I, and is it phyllox-era (fylocksera) or phyllo-xera (fylo-sera).—I am, &c.,

Alfred H. Allen.

RADICAL OR RADICLE?

To the Editor of the Chemical News.

Sir,—The letter which Dr. Divers addressed to you (Chemical News, vol. liv., p. 36) as a protest against what he holds to be the incorrect mode of spelling adopted by the Editor and Publication Committee of the Chemical Society, reminds me of the discussion started twenty-two years ago in the correspondence columns of the Chemical News (vol. ix., pp. 143, 166, 191, &c.).

In the year 1864 the transition from *radical* to *radicle* was beginning to find favour, owing, perhaps, to the then recent appearance of the article on Acetyl in "Watts's Dictionary, and, under my initials J. S., I wrote you a couple of letters showing that, out of forty-nine communications examined, the authors, commencing with Hofmann and Brodie, had in thirty-three instances followed the old style of spelling, whilst only sixteen adopted the new word "radicle." You were then with me (see Editorial Note, p. 167) in advocating the retention of the old word, for which Dr. Divers now pleads.

The learned professor will see his manuscript altered in the current *Journal of the Chemical Society* (Divers and Shimidzu on "Mercury Sulphites and the Constitution of Sulphites"), printed copy of which cannot yet have reached him in Japan, and the spelling throughout made to accord with Prof. G. C. Foster's article on Radicles in "Watts's Dictionary," or rather with the Society's editorial dictum.

I submit that the arguments adduced by Dr. Divers in his recent letter to you are unanswerable, or at least have not been met by Mr. Madan in his last week's reply.—I am, &c.,

John Spiller.

London, August 10, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 4, July 26, 1886.

Determination of Ammonia.—Th. Schlœsing.—Calcined magnesia is constantly used in agricultural laboratories to displace ammonia from its saline combinations and to permit its extraction by distillation and its volumetric determination. Its use has been especially recommended by M. Boussingault, after careful study, for determining ammonia in presence of nitrogenised organic substances, and recommendations have been reproduced by M. Peligot and M. Grandeau in their treatises of agricultural chemistry. If magnesia does not permit the extraction of the totality of the ammonia from dissolved magnesian salts, it must be admitted that the authors just mentioned have adopted a quite insufficient method for determining one of the most important substances in agriculture. The scientific labours of M. Boussingault on the ammonia contained in organic substances and the results obtained by the author in his researches on atmospheric ammonia will be gravely compromised. It is only after the most careful verification that he has adopted a process founded on distillation in presence of magnesia for the determination of ammonia. M. Schlœsing then recounts his recent experiments, the results of which do not agree with the conclusions of MM. Berthelot and André.

Slow Decomposition of the Chlorides in their Dilute Solutions.—G. Foussereau.—In a former paper the author has the results of a study on the decomposition of ferric chloride by water observed by means of the variations of electric resistance. He has now extended his observations to the aluminium, magnesium, double rhodium, and sodium, platinum, and gold chlorides.

New Experiments on the Electrolysis of Hydrofluoric Acid.—H. Moissan.—(See p. 80).

Separation of Antimony and Tin.—Ad. Carnot.—This paper also will appear in full.

Numerical Laws of Chemical Equilibria.—H. Le Chatelier.—A mathematical paper not susceptible of useful abstraction.

On the Sodium Manganites.—G. Rousseau.—Manganese chloride introduced in small quantities into an alkaline earthy oxychloride kept in fusion in contact with the air is quickly transformed into manganate. On prolonged heating the manganate is dissociated, forming manganites whose complexity varies with the temperature. The author has succeeded in producing two varieties of sodium manganite by the following process:—3 grms. caustic soda are melted in a platinum crucible over a Bunsen burner; 1·5 grms. dried manganese chloride is added, and there are lastly introduced 3 grms. sodium nitrate. The mixture is kept in fusion at dark redness, constantly stirring. When the greater part of the sodium nitrate is decomposed the temperature is raised to the volatilisation point of potassa and the heat is continued for about four hours, leaving the crucible uncovered.

Determination of the Absolute Acidity of the Organism and on Certain Phenomena Relating to the Saturation of Orthophosphoric Acid.—Ch. Blarez.—The exact determination of the absolute basicity of phosphoric acid is not possible, since this basicity is not absolute; a molecule of acid may, according to circumstances, unite not only with one or two mols. of base to form definite salts, but also with a larger quantity. As phosphoric acid and the phosphates form part of the constituent principles of animal liquids it is impossible to determine the absolute acidity of these liquids in presence of a body requiring a variable quantity of base for their theoretical neutralisation.

Certain Thermic Data Concerning the Chromates.—Paul Sabatier.

Thermic Researches on the Selenides.—Charles Fabre.—For the results of these two papers we must refer to the original.

Researches on Certain Crystalline Basic Sulphates.—M. Athanasesco.—By means of Friedel's process the author has obtained well-crystallised basic sulphates of cadmium, zinc, aluminium, iron and aluminium, and, by a slightly modified process he has formed basic sulphates of nickel, cobalt, mercury, and bismuth. All these bodies are insoluble in and undecomposable by water; aluminium sub-sulphate is insoluble even in boiling acids. All except that of mercury contain water which, in the majority of cases, is eliminated only at very high temperatures, sometimes above 300°, and is probably, therefore, combined water.

Researches on Certain Crystalline Arseniates.—M. Coloriano.—All these arseniates, except the bibasic ones are insoluble in water and are not readily attacked by acids. The hydrated basic acids retain their water up to a very high temperature.

A Nitro-Camphor and on its Saline and Alcoholic Combinations.—P. Cazeneuve.—On treating normal chloronitrous camphor by zinc, copper, iron, or alkalies in presence of dilute alcohol it is decomposed with formation of a metallic chloride and oxide or an alkaline chloride or chlorate, whilst there is formed a true salt of nitro-camphor united with the metal in question.

Discussion of the Reactions of Pilocarpine.—E. Hardy and G. Calmels.—This memoir does not admit of useful abridgment.

Physiological Function of the Pulmonary Tissue in the Exhalation of Carbonic Acid.—L. Garnier.—There exists in the pulmonary tissue a body of an acid function distinct from taurine. Whether or not this body is Verdeil's "pneumic acid" the fact of the acidity of the lungs is in itself of great physiological importance.

Chromatometer for Measuring the Colour of Liquids.—L. Andrien (de l'Etang).—This paper requires the accompanying illustration.

Zeitschrift für Analytische Chemie.
Vol. xxv., Part 3, 1886.

Applicability of Malleable Nickel for Chemical Apparatus.—Fr. Stolba.—Noticed some time ago.

Organic Impurities in Hydrochloric Acid.—F. Schrœder.—The acid in question is obtained as a by-product in the manufacture of certain organic substances and can generally be detected by its odour. Such acid is inadmissible for scientific and for pharmaceutical purposes.

Neutral Litmus Paper.—K. Mays.—100 grms. of litmus, without pulverising, are boiled in 700 c.c. of water, which is then poured off, and the residue is again boiled up with 300 c.c. of water. The mixed extracts are allowed to settle for one to two days, acidulated with hydrochloric acid and dialysed in a current for 8 days. Unsized paper is then prepared in the ordinary manner with this neutral solution of litmus.

Electrolytic Separation of Metals.—M. Kilian.—From solutions containing salts of various metals the metals may be completely and successively separated in a state of purity by using currents of different strengths. The current first applied must be only sufficient to throw down the most readily precipitable metal, but not the next following. The more of this first metal is deposited the feebler becomes the current, and finally a galvanometer introduced into the circuit is no longer affected; a sign that now none of the metal precipitable by the existing electromotive power is present, but only such saliae solutions as do not conduct the feeble current and consequently are not decomposed. If the negative electrode is charged and the electromotive power increased a second metal can be precipitated.

Electrolytic Separation of Molybdenum.—E. F. Smith and W. S. Hoskinson.—From the *American Chemical Journal*.

Electrolytic Determination of Mercury.—Luis de la Escosura and Horacio Bentabol y Ureta.—The author's process has been already inserted. Prof. Classen writes that he communicated this process to Don L. de la Escosura two years ago, whilst Don H. Bentabol y Ureta's memoir bears date January 15th of the present year.

A New Method for Separating Iron and Alumina.—M. Flinski and G. von Knorre.—This paper will be inserted in full.

A New Method for the Determination of Cadmium.—Ad. Carnot and P. M. Proromont.—Inserted from the *Comptes Rendus*.

Determination of Arsenic.—F. Reich and Th. Richter.—This method has been discussed in the Chemical News by Leroy McCay, A. H. Low, and others.

Action of Potassium Permanganate upon Sodium Hyposulphite.—M. Hönig and E. Zatzek have stated that in alkaline solutions the alkaline hyposulphites are completely converted into sulphates by potassium permanganate even in the cold. M. Gläser has examined the equation of decomposition proposed by the former chemists and pronounced it incorrect. Hönig and Zatzek had further stated that in neutral solutions the oxidation of the hyposulphites by permanganate is incomplete. Gläser, on the contrary, obtained a complete transformation of sodium hyposulphite into sulphate by adding solution of permanganate to the boiling solution of the former salt until a permanent redness was produced. Hönig now replies that his oxidation experiments in neutral solutions were conducted not at a boiling heat but at ordinary temperatures.

The Precipitation of Silver Chloride, Bromide, and Iodide from Solutions containing Antimony Oxide and Tartaric Acid.—R. Schneider.—From *Journal für prakt. Chemie*.

The Alkaloids of the Cinchona Barks.—O. Hesse.—From *Liebig's Annalen*.

The Analysis of Gaseous Haloid Compounds of the Hydrocarbons.—Carl Seubert.—From the *Berichte der Deutsch Chem. Gesellschaft.*

Determination of the Nitrogen of Organic Substances.—A. Houzeau.—Noticed under *Comptes Rendus* (vol. c., p. 1445). It is here stated that the same method was proposed some years ago by C. Arnold. The methods of Ruffle and of Dumas (the latter according to the modification of S. W. Johnson and E. H. Jenkins) have been compared by C. W. Dabney, Jun., and B. von Herff with fairly concordant results. J. Cosack has compared König's oxidation and reduction method with the processes of Varrentrapp, Ruffle, and Grete. With certain guanos, especially those rich in ammonium urate, it gives lower results than the other methods. C. Brunnemann and F. Seyfert (*Chemiker Zeitung*) give certain directions for the execution of Kjeldahl's method. They recommend round-bottomed boiling flasks supported on wire network. They find that the addition of phosphoric anhydride prevents bumping. R. Warington (Chemical News) has examined the applicability of Kjeldahl's process in presence of nitrates.

Determination of Gaseous Cyanogen in Presence of Carbon Dioxide and Monoxide, Nitrogen, and Oxygen.—G. Jacquemin.—Noticed under *Comptes Rendus.*

The Titration of Phenol with Bromine.—Carl Weinreb and S. Bondi.—In carrying out Koppeschaar's method only 6 atoms of bromine are consumed, or appear to be consumed, to 1 mol. phenol. They point out that this method gives good results with pure phenol, but that it is unsuited for the determination of phenol in crude carbolic acid.

Detection of Liquorice in Beer.—R. Kayser.—For this paper the reader is referred to the *Chemiker Zeitung* (ix., p. 781).

Determination of Gluten.—Balland.—From the *Comptes Rendus.*

Detection of Oil of Turpentine in Oil of Citron.—G. Heppe.—The sample is heated to 172° in a dry test-tube with dry pulverised copper butyrate. Pure citron oil dissolves this salt with a green colour. In presence of oil of turpentine the mixture becomes turbid yellow and deposits cuprous oxide.

Examination of Fats and Oils.—A series of passages from *Dingler's Journal*, the Chemical News, the *American Chemical Journal*, the *Analyst*, and the *Chemiker Zeitung.*

Composition and Analysis of Wax.—Otto Hehner.—From the *Analyst.*

Determination of Metallic Zinc in Zinc Powder.—Morton Liebschütz.—The author moistens 1 grm. of the sample, after removing any metallic iron by means of a magnet, with alcohol in a beaker glass, stirs it with a small platinum rod, and covers it with a warm neutral solution of 5 grms. copper sulphate. After digesting for some minutes the mixture is acidified with a few drops of dilute sulphuric acid. After the copper has deposited the liquid is poured through a small filter, and the deposit is washed by decantation with warm water until copper can no longer be detected in the filtrate by means of potassium ferrocyanide. The copper along with the ash of the filter is then dissolved in nitric acid, any lead here present is removed, the solution is made up to a known volume, and the copper is determined volumetrically in an aliquot part thereof by means of potassium cyanide. Kosmann (*Chemiker Zeitung*) remarks that he proposed this method in 1883 and described it in full.

Determination of Nitric Acid in Manures.—Shepherd and H. B. Yardley.—From the Chemical News.

Testing Commercial Feeding-Stuffs.—A. Emmerling (*Chemiker Zeitung*).—The meals, foods, comminuted cake, &c., are introduced into stoppered bottles which have previously undergone an elaborate purification and are made up into a thin paste with distilled water. The bottles are then placed in a stove at 35°, and, after twenty four hours, portions are submitted to microscopic examination.

Adulteration of Menthol with Thymol.—F. A. Flückiger.—The author doubts the possibility of this sophistication, as, if these two substances are mixed in equal parts, both become liquefied. Menthol is also mixed with paraffin, the solid fats, and camphor.

Testing Cocaine Hydrochlorate.—H. Beckurts.—A solution of 0·01 of the sample in 25 c.c. of water should not become brown on the addition of a drop of decinormal permanganate, and, on the addition of a few more drops, becomes turbid in consequence of the formation of a violet-red precipitate.

Examination of Quinine.—C. H. Wood and E. L. Barret.—From the Chemical News.

Determination of Morphine in Opium.—W. Bernhardt.—The author rubs up 1 grm. powdered opium with water, filters, washes the undissolved matter with water until the washings run off colourless and a drop tested with ferric chloride no longer shows the presence of meconic acid. For this purpose 30 to 40 c.c. of water are necessary. The solution is evaporated down to 25 c.c. and mixed in a test-tube with 5 drops of ammonia and 10 c.c. of ether, shaking frequently. After standing for twelve hours the ether is completely removed by decantation and the application of blotting-paper, the morphine which separates out as a crystalline powder is collected on a tared filter, the last traces of the mother-liquor displaced by a little ether, dried, and weighed.

Examination of Solutions of Morphine.—Egeston, Jannings, and Bedson.—From the *Lancet.*

Applicability of Kjeldahl's Method in Metabolic Researches.—C. Arnold.—The author has obtained satisfactory results.

Determination of Urea with Bromine-Water.—E. Salkowski.—The author uses the apparatus proposed by Schulze-Tiemann for determining nitric acid in water as nitric oxide. The urine is diluted with 5—10 parts of water and 25 c.c. are then placed in the flask, an equal volume of water is added along with 2 drops of hydrochloric acid, the stopper, bearing the tube connections is inserted, the gas-delivery tube is closed, and the flask is heated to an incipient boil. The flame is then withdrawn, the ascending tube filled with hot water, the clamp of the gas delivery tube opened, and the flask boiled free from air. When this has taken place the clamp is closed, a considerable quantity of bromine-liquor (prepared from 5 c.c. bromine, 60 c.c. soda-lye of sp. gr. 1·34, and 30—35 c.c. water (previously well boiled) is allowed to enter, and the liquid heated to a boil after closing the clamp of the ascending tube, until over-pressure is perceptible. If the caoutchouc portion of the delivery tube is then set free the nitrogen streams into the measuring-tube. To obtain it entirely the boiling is continued for some time.

On Neubauer's Determination of Creatinine in Urine.—E. Salkowski.—In this memoir, taken from the *Zeitschirft f. Physiol. Chemie*, the author suggests certain improvements on Neubauer's process, for which we must refer to the original.

On Heteroxanthine.—G. Salomon.—Heteroxanthine occurs in the mother-liquors from the preparation of paraxanthine, from which it readily separates, owing to its sparing solubility.

Detection of Biliary Colours in Urine.—C. Deubner.—The author gives the preference to the reactions of Rosenbach and Hilger.

Separate Determination of Albumen and Globulin.—Neutral ammonium sulphate completely precipitates the true albumens from their solutions, the globulin being first precipitated and then the albumen.

Detection of Oxalic Acid in Urine.—E. Salkowski.—An application of Neubauer's process of determining creatinine. The alcoholic precipitate contains, along with chlorides, calcium sulphate and urates, and calcium oxalate. By repeated washing with alcohol at 80 per cent and a little hot water, solution in a little dilute hydrochloric acid, neutralising with ammonia, acidulation with acetic acid, and standing for 24 hours, calcium oxalate is separated out in well-developed crystals.

Determination of Phosphoric Acid in Presence of Iron and Aluminium.—Julius Laubheimer (*Chemiker Zeitung*).—The solution (25 or 50 c.c., containing 0.1=0·2 grm. phosphoric acid) is mixed with 10 c.c. solution of citric acid (500 grms. per litre), and then with a large excess of strong ammonia. After the mixture has become somewhat cool it is precipitated with 15 to 20 c.c. of the ordinary (not sulphated) magnesia mixture. The crystalline ammonium-magnesium phosphate is filtered off after standing 12 hours and is washed first with ammoniacal water and then with alcohol. By ignition over the ordinary burner there is obtained white magnesium pyrophosphate, which rarely requires to be moistened with nitric acid. In strongly ferriferous phosphates (*e.g.*, Thomas and Gilchrist slags), 20 c.c. of citric acid are used and a corresponding increase of ammonia. It is then necessary, after adding the magnesia mixture, to stir the liquid for some minutes until it has become turbid.

Application of the Marsh-Berzelius Method to the Quantitative Determination of Arsenic.—W. P. Headden and B. Sadler.—It is merely mentioned that the results have not been encouraging.

The Ptomaines.—The results of the Italian Commission are given in a book of 75 pp.

Reaction for the Identity of the Strychnos Preparations.—O. Schweissinger.—A granule of the extract, if heated in a porcelain capsule with a drop of dilute sulphuric acid, gives an intense violet colour, which disappears on dilution with water and re-appears on concentration. This reaction is due, no. to the alkaloids, but probably to the glucoside loganine.

Observations on Poisoning by Atropine.—J. Kratzer.—A perfect demonstration of the presence of atropine can be reached only by means of physiological experiments.

Unity of Atomic Weights.—L. Meyer and K. Seubert.—The authors point out as a source of confusion that the atomic weight of oxygen is in some cases assumed = 16 and in others = 15·96. They recommend that the former value should be set aside.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Note on Prussian Blue as a Colouring-Matter of Sandstone—I noticed in a wall near where I live three or four pieces of sandstone of a blue colour, and thinking this rather peculiar I took a piece of it for examination. The sandstone is of a yellowish brown colour, with here and there streaks and masses of a blue colour. Judging from appearances I should have said the colour was due to copper, but upon testing for copper I could not find any. Iron was found to be present both in the colouring matter and in the rock itself; a ferrocyanide was also found to be present, and this of course conclusively proved that the colour was due to Prussian blue (ferric ferrocyanide). It might be thought that the colour is not natural, but as the colour has penetrated right into the centre of the stone we cannot doubt but that it has been formed in a natural manner; how it has been formed I cannot say, but it is evidently by the action of some substance on the ferric hydrate contained in the rock.—H. B. S.

ERRATA.—P. 71, col. 2, line 6 from bottom, *for* "telegraphene" *read* "telegrapheme." Line 8 from bottom, italicise "*cis*." Line 13 from bottom, *for* "substantially" *read* "substantivally."

TO CORRESPONDENTS.

W. P.—See review of "Art of Soap-Making," in CHEM. NEWS, vol. liii., p. 199.

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THE CHEMICAL NEWS.

Vol. LIV. No. 1395.

ON THE PREPARATION OF IODALDEHYD.

Remarks on the Paper of Messrs. W. Popplewell Bloxam and E. F. Herroun.

By P. CHAUTARD.

In the Chemical News of 25th June last (vol. liii., p. 301) there is an interesting article by Messrs. Popplewell Bloxam and Herroun, on Iodaldehyd, in which these gentlemen make some observations on a memoir which I presented on this subject to the Academie des Sciences at the commencement of the year, and which has been printed in the *Comptes Rendus*. In reply to these observations and to some questions I have prepared the accompanying note, which I shall be very pleased to see printed in your estimable journal.

It is now some time since Aimé and Johnston, in order to order to obtain an iodised derivative of aldehyd, oxidised an alcoholic solution of iodine by means of nitric acid, but they only gave very little attention to this reaction, and their results were not very reliable; they evidently only obtained mixtures.

Messrs. Popplewell Bloxam and Herroun have made fresh researches on this oxidation, and the results of their work form an interesting memoir which appeared in this paper (Chemical News, vol. liii., p. 301). Besides nitric ethers and cyanogen derivatives, they have obtained a body whose properties resemble very closely those which I have already described as belonging to iodaldehyd. Although they have not been able to isolate it, nor for that reason to analyse it, I feel certain that the product they have been dealing with is identical with that which I prepared myself by the action af a mixture of iodine and iodic acid on an aqueous solution of aldehyd. Their product decomposes when distilled at a temperature of 80°: this is the same point of decomposition that I found. Its smell and irritating action on the mucous membrane, its easy transformation into iodoform under the influence of bases, belong also to iodaldehyd, and, further, the manner in which it behaves with the different reagents show a still greater similarity.

I regret that these gentlemen did not try the effect of bisulphite of soda, ammonia, and cyanide of potassium; they would, in all probability, have obtained the combinations which I prepared and described, and which would have proved beyond all doubt the identity of the two bodies.

Messrs. Popplewell Bloxam and Herroun have tried to prepare iodaldehyd by my process; they have followed to the letter the instructions I gave, and, although they say they have had proof of its presence, they have not been able to isolate it. I have been searching for the reason of this non-success.

In my memoir to the Academie des Sciences I recommended using 50 grms. of aldehyd at a time; this quantity appeared to be too much to Messrs. Popplewell Bloxam and Herroun, who used very small quantities. I have been thinking that the mass of the product and the duration of the operation might have an influence on its success: to verify this I made a preparation of iodaldehyd, starting with 5 grms. only of aldehyd, and I succeeded perfectly. Thus, when one proceeds in the manner I have indicated, the question of quantity has no influence on the results.

As far as the duration of the operation is concerned, I have already published the fact that the reaction is completed in three or four days in the summer and eight days in the coldest part of winter. Now Messrs. Popplewell Bloxam and Herroun have remarked that in all their experiments the duration of the operation has been much longer than I have indicated, and sometimes as long as several weeks. This is entirely a question of temperature. In the course of my experiments the matrass in which I carried out the operations remained in the laboratory on a staging placed over a stove, and where the temperature averaged 30° to 40°. In the case of these gentlemen the temperature was doubtless lower, and that explains the abnormal duration of the operation. In my opinion it is entirely because their operations have been conducted too slowly that Messrs. Popplewell Bloxam and Herroun have not been able to precipitate an appreciable quantity of iodaldehyd by the addition of water. In fact I have several times had to leave a matrass, in which I have prepared iodaldehyd, for several weeks after the action was completed, and when, after this lapse of time, I added water to precipitate the iodaldehyd, I noticed that the quantity of heavy oil which fell was always notably less than the quantity I should have had (one-fourth to one-fifth less than the normal yield), and further, that it was charged with a large quantity of iodine. This is owing to the fact that iodaldehyd is partially decomposed after long contact with water.

In the case of Messrs. Popplewell Bloxam and Herroun the reaction proceeded very slowly; at the moment when the solution of the iodine was complete a part of the iodaldehyd produced was already decomposed, by cause of its prolonged contact with the water, and when they added more water the iodaldehyd which still remained was not present in sufficient quantity to supersaturate the water, and thus to become precipitated; it dissolved entirely, and its presence in the liquid was only noticed by the manifestation of properties which these gentlemen have observed, and which agree with the description which I gave of the properties of iodaldehyd.

At the commencement of my researches I operated on small quantites of matter and at low temperatures,—that is to say, under conditions analogous to those in which Messrs. Popplewell Bloxam and Herroun have been working, and I had much trouble in getting any results; it is only by using large quantities that I have been able to succeed in my work.

The purity of the iodic acid used is also of some importance; it occasionally happens that the iodic acid, especially when it is well crystallised, retains considerable quantities of sulphuric acid; in this case the sulphuric acid is set free by the solution of the iodic acid, and it decomposes a part of the iodaldehyd as it gradually forms: this is another cause of failure.

I did not specify all the conditions for successful working in my note to the Academy of Sciences, because my note there was only preliminary, and sent in principally to take precedence, and to reserve to myself the continuation of this research; besides this, I have since introduced modifications into my mode of working, which I shall publish before long. I have also succeeded in preparing iodaldehyd by different methods, notably by the action of iodine on the aldehydate of ammonia. Further, I have applied the same process of ioduration to a certain number of aldehyds of the fatty series, and I have obtained a whole series of combinations which I shall make known in a paper towards the end of the year.

To sum up, I keep to the terms of my memoir, that in operating exactly as I have described we can produce iodaldehyd with the greatest ease. I do not mean, be it well understood, anything beyond common iodaldehyd, for the purification of this body is an excessively long and difficult operation; it is necessary to start with 500 grms., at least, of impure iodaldehyd, to obtain 15 or 20 grms. in the state sufficiently pure for analysis.

Messrs. Popplewell Bloxam and Herroun, in the course of their paper, quote a work of Schoonbroodt on iodal. The conclusions of this author are erroneous. He pre-

tends to have obtained, by the action of an aqueous solution of hypochlorite of potash, or an alcoholic solution of iodine, a crystalline precipitate, which resolved itself into iodoform and formic acid under the influence of bases, and which he named iodal. I have often repeated this experiment, and I am convinced that the crystalline precipitate which does in fact form is composed exclusively of iodide of potassium and iodoform; this latter is produced by the action of the free potash which always occurs in solutions of hypochlorite of potash, or the alcoholic solution of iodine. I have never noticed, no matter how carefully I have worked, the presence of any other body whatever.

Messrs. Popplewell Bloxam and Herroun have done me the honour of asking me to explain the reaction in virtue of which iodaldehyd is transformed into iodoform. It is impossible for me to answer them on this point, but I have undertaken a research with the idea of elucidating this question, and I hope before long to arrive at a satisfactory result.

47, Rue Olivier de Serres, Paris,
August 9, 1886.

BEHAVIOUR OF MAGNESIA CONTAINING RARE EARTHS (?).

BY GEORGE STILLINGFLEET JOHNSON.

SOME *calcined magnesia* (Hopkin and Williams) was allowed to slake under cold water, when the reaction of the water was found to be strongly alkaline. This alkalinity being attributed to sodium carbonate, the hydrated magnesia was subjected to prolonged washing by decantation with boiled distilled water. It was observed that, although the water above the precipitate had always a very marked alkaline reaction immediately after *thorough stirring*, this reaction disappeared after standing some hours at rest, though no turbidity appeared in the supernatant liquor. The washings gave a crystalline precipitate with ammonia and ammonium oxalate on prolonged standing. At this stage—the washing having been continued for many days, and the presence of alkali metals being considered extremely improbable—some of the precipitate was dissolved in HCl, and the solution poured upon the remainder together with about 2 litres of distilled water. The precipitate was then frequently stirred with the supernatant solution, heat being also applied from time to time. Still the same alkaline reaction was apparent immediately after stirring, and disappeared on standing.

After about a week's digestion the supernatant liquor was decanted off and precipitated by baryta water. The filtrate was freed from Ba by ammonium carbonate, and the filtrate from $BaCO_3$ was evaporated to dryness, and ignited to expel ammonium salts. The residue, after ignition, was extracted with water, and the portion insoluble in water was dissolved in HCl.

The aqueous solution gave precipitate with H_2SO_4, also with Na_2HPO_4 in alkaline solution. No precipitate with $(NH_4)_2CO_3$, even on boiling.

The acid solution gave very little precipitate with dilute H_2SO_4, but a very abundant precipitate with Na_2HPO_4 in alkaline solution. No precipitate with $(NH_4)_2CO_3$, even on boiling.

The MgO is therefore supposed to contain an earth whose oxide is soluble in water and very alkaline, whose carbonate is soluble, whose sulphate is insoluble; also another earth whose sulphate is soluble, but its phosphate insoluble in alkaline solution, its carbonate being also soluble, like the first.

King's College Laboratory, August, 1886.

Distinction between the Milk of Women and of Cows.—E. Pfeiffer and J. Schmidt.—The casein of the former milk, like the latter, is precipitated by acids if heated, but the former falls in fine flocks.—*Zeitschrift.*

REDUCTION OF CARBON DIOXIDE BY POTASSIUM CYANIDE.

By ARNOLD EILOART, B.Sc.

POTASSIUM cyanide placed in a porcelain boat and heated in a combustion-tube traversed by a stream of CO_2 dried by H_2SO_4, blackened; fused; whitened again; increased in weight; and caused formation of carbon monoxide. Later, as the heat was increased till the glass was near fusing, the substance began to volatilise, losing weight; when, after many days, the formation of gas unabsorbed by potash ceased, the weight was but a third of the original. The residue was practically all potassium cyanate, of which the cyanide used had contained a mere trace. The amount of KCy oxidised is calculated on the percentage (97·8) which the substance contained when put into the tube; but it was observed that always after weighing the white residue it darkened at first on heating, so that a minute portion was probably decomposed owing to momentary exposure to moist air in transferring the boat to the stoppered tube in which it was weighed; for pure KCy is said not to blacken on heating, and this specimen (once the blackening first formed had burnt off) did not darken when cooled and re-heated without opening the tube.

Substance taken—0·131 grm., containing 97·8% or 0·126 grm. KCy. CO found—42·7 c.c. at zero and 760 m.m. = 0·0538 grm. Theory—0·0543 grm. for the equation

$$KCy + CO_2 = KCyO + CO.$$

King's College Laboratory, August, 1886.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 79.)

X. *Relation between Silver and Potassic Chloride, y* 14—26.

IN the year 1860 (*a* 271, 272) M. Stas had already published twenty-one estimations of this relationship, in which he put almost absolute confidence (*a* 256, 332). In 1857, however, G. J. Mulder† showed that the solution of nitrate of silver, with a chloride carefully added until the solution was clear, still gave a precipitate with a decinormal solution of nitrate of silver. By adding this solution very cautiously we reach the *silver limit*, where the liquid is no longer troubled by nitrate of silver, but is by a chloride. To get from one limit to another, which can be repeated indefinitely, it is necessary to have quantities of silver and chloride exactly equivalent. Mulder concludes that the mean of these limits represents the true proportional relationship. In this manner the liquid shows an opalescence of equal intensity with the same volumes of decinormal solutions of salt and nitrate of silver. The same reaction occurs in the case of nitrate of silver and hydrochloric acid. When M. Stas published his first two memoirs he did not ignore this *reciprocal precipitation*, which, by-the-bye, had been observed previously by Mulder, Gay-Lussac, and the chemists of the Hotel de la Monnaie at Utrecht. M. Stas‡ communicated some minute researches on this subject in 1872 and 1874. He noticed that chloride of silver, *broken up* or *powdered*, is *soluble in water*, to the extent of 13 m.grms. per litre, and that it is eliminated from its solution by the addition of a quantity of chlorine or silver *three times* as much as that which dissolved in the state of combination.

All the estimations of silver, its chlorides and bromides

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.
† "De Essaycermethode van het Zilver," Rotterdam, 1857.
‡ *Annales de Chimie et de Physique*, vol. xxv., p. 22, 1872, and vol. iii., pp. 145 and 289, 1874.

have been done according to the method that Pelouze suggested to Marignac in 1842. The salt and the silver are weighed as accurately as possible, and their solutions are then mixed. Then the slight residue of silver or of the halogen which remains uncombined is weighed.

In the estimations published in 1860 and 1865 M. Stas always added the salt solution until the cessation of all precipitates (α 269, β 47). Thus it was the limit of salinity that he determined. After his researches on the solubility of chloride of silver he considered it to be a duty to submit his previous work to a severe control, by determining (first method) the saline limits of silver, of which the arithmetic mean would be the true relationship, and (second method) the point when the opalescence of the liquid is the same as that produced with decinormal solutions.*

I cannot understand why the relation found in 1860 or 1865 should always be *lower* than that of 1882, nor why the difference reaches $\frac{1}{1000}$ for chloride of potassium and is hardly anything for chlorides of sodium and ammonium. Whatever may be the reasons, the estimations of 1882 are the most exact, and are the only ones which I have used in my calculations.

For chloride of lithium we must be contented with the experiments of 1865, because M. Stas has not repeated them.

Bromide of silver is altogether insoluble in cold water, and does not show the complications described in the above determinations. It is for this reason that M. Stas prefers bromine to chlorine for the silver determinations.

To obtain equal weights of silver and of halogen salts *I subtracted from the weight of silver used* the weight of the superfluous metal, or added the weight of silver which was wanting to the supernatant liquid of the chloride or bromide of silver first formed.

After these necessary explanations I give the tables of results, adding the quantity of silica contained in the halogen salts.

(To be continued.)

THE SEPARATION OF ANTIMONY AND TIN.

By AD. CARNOT.

The author has sought to apply to this problem a method analogous to that which has proved successful for the separation of zinc and cadmium, founded on the simultaneous use of oxalic acid and sodium hyposulphite. Oxalic acid in faintly acid hydrochloric solutions of tin and antimony gives white crystalline precipitates of the simple oxalates of these metals. In presence of an ammoniacal salt there are formed double oxalates much more soluble than the foregoing. These salts crystallise only from crystalline solutions, and they may be diluted with much water without turbidity. They consequently can yield solutions of tin and antimony very faintly acid and yet perfectly limpid, conditions favourable for the analyses. These solutions of oxalates have some analogy with those of the double tartrates. One of the simplest methods of preparing them consists in pouring into the solution of the metallic chlorides, according as it is more or less acid, ammonia or ammonium chloride, then oxalic acid, and lastly ammonia to almost complete saturation. If a precipitate forms it is re-dissolved by a trifling excess of oxalic acid. In such a solution sulphuretted hydrogen precipitates entirely the antimony as an orange sulphide; with stannous salts it gives a black precipitate; it precipitates the stannic salts incompletely, especially if the solution is hot and contains a rather large proportion of free oxalic acid. The black colour of the stannous sulphide attracted the author's attention. Such, he finds, is the true colour of stannous sulphide when absolutely pure; the maroon-brown ascribed to it in the text-books is due to a mixture of the black stannous sulphide with a larger or smaller proportion of the yellow stannic sulphide. If we pass a current of hydrogen sulphide into a hydrochloric solution of stannous oxide, there is produced a brown precipitate; in the oxalic solution of the same salt the precipitate is at first of a fine black, but if it is allowed to cool in a stoppered bottle the black deposit of stannous sulphide soon becomes covered with a thin yellowish layer of stannic sulphide.

Sodium hyposulphite in a hydrochloric solution of tin, at a boiling-heat, produces a yellowish white precipitate, containing sulphur and tin sulphide and oxide. In an oxalic solution, on the contrary, only sulphur is deposited, all the tin remaining dissolved. Sulphurous and sulphuric acid no longer produce in it any precipitate, contrary to what happens in a faintly acid hydrochloric solution.

As for the antimony salts, acidified either with hydrochloric or oxalic acid, they yield, on boiling with hyposulphite, an escape of sulphurous acid, and a precipitate, yellow at first, but passing into orange, vermilion, and then to cinnabar-red. This precipitate consists of sulphur and antimony oxysulphide. If it is carefully washed and dried, heated to about 110°, and, if the free sulphur is dissolved out with carbon disulphide, the residue—which is of a fine red—answers exactly to the formula Sb_2OS_2.

The precipitation is complete only at a boiling-heat, and in presence of a small quantity of free hydrochloric acid. It is in danger of remaining imperfect if the liquid is acidified only with oxalic acid.

As a consequence of the foregoing observations, and after very numerous experiments, the author advises the following procedure for the rapid and exact separation of the two metals:—

The hydrochloric solution of tin and antimony is mixed with ammonia or ammonium chloride; about 2 grms. of oxalic acid, previously dissolved, are added and then ammonia almost to saturation. The liquid is diluted to 250 or 300 c.c., and there is added a solution of hyposulphite containing at least 10 parts of this crystalline salt to 1 part of the antimony to be determined. The liquid, which is clear at first, becomes turbid on heating and passes successively to yellow and red. From 1 to 22 c.c. of dilute hydrochloric acid are added and the boiling is kept up for some minutes. On ceasing to heat the red precipitate is deposited and the liquid quickly becomes clear. On adding, further, a few drops of hydrochloric acid and boiling for some moments, we observe the aspect of the liquid. If it remains clear a little hyposulphite must be added. If it is milky and entirely white the precipitation of the metal is complete. But if it takes a yellow or reddish colouration, antimony remains in solution, and the addition of acid (and sometimes of hyposulphite also) must be repeated until the turbidity is purely white. The oxysulphide, mixed with sulphur, is collected on a tared filter, where its consistence allows it to be easily washed. If a red coating of oxysulphide adheres to the glass, it is taken up with a minimum of hydrochloric acid, the hydrogen sulphide is expelled, the liquid is diluted and again precipitated with hyposulphite at a boil; or it may be dissolved with 3 or 4 drops of hydrosulphate (ammonia), and after dilution it is decomposed with hydrochloric acid. In either case the precipitate is added to the former upon the filter. The filtrate contains all the tin; it is saturated with ammonia while still hot; the precipitate is re-dissolved in hydrosulphate and the sulpho-salt is decomposed with acetic acid. Hydrochloric acid is not applicable. In a short time the precipitate subsides and is received on a filter, washed with water and a little ammonium nitrate, dried, and ignited in a porcelain crucible, and weighed as stannic oxide. As for the antimony oxysulphide, it is always mixed with an

* Mulder discovered the first method, while the second has been used since 1839 in the Monnaie d'Utrecht, where it was introduced by Van Setten. It was also Van Setten who discovered the solubility of chloride of silver in pure water.—*Journ. de la Soc. Hollandaise de Pharmacie* (Tydschrift van Haaxman, 1858, p. 15).

excess of sulphur, and may be converted into antimony tersulphide by simple calcination in a current of dry carbonic dioxide. Or, after having separated the two metals as above, the red oxysulphide may be dissolved in hydrochloric acid whilst still moist, and the antimony may be determined volumetrically.—*Comptes Rendus*, ciii., p. 258.

ON THE

CHEMICAL COMPOSITION OF HERDERITE AND BERYL,

With Note on the Precipitation of Aluminum and Separation of Beryllium and Aluminum.*

By S. L. PENFIELD and D. N. HARPER.

1. *Composition of Herderite.*

The rare material for carrying on the present investigation of herderite was given to us by Mr. L. Stadtmüller and Prof. George J. Brush. The crystals were carefully picked by hand, and freed as far as possible from all foreign matter. They were then crushed and sifted, and suspended in the Thoulet solution; only the material whose specific gravity was greater than 2·95 was used for analysis. By this means there was separated from the hand-picked crystals a little questionable material, which was used in making a sort of preliminary analysis, and we were able to obtain over 5 grms. of very pure material. Before making the separation with the Thoulet solution we carefully took the specific gravity of some of the purest crystals by taking the specific gravity of the solution in which they were suspended without floating or sinking. This we found to be from 3·012 to 3·006, the heaviest being the specific gravity of a very clear transparent crystal, while the more opaque and cracked crystals were a trifle lighter. The mineral is so much heavier than the quartz and felspar to which the crystals were attached that we feel very confident of the purity of the material which we analysed.

The analysis was made after we had had considerable experience in the determination of beryllium, and had made some experiments in determining it in presence of phosphoric acid. The method which we adopted gave good satisfaction, and we give it here somewhat in detail. The mineral was dissolved in nitric acid, the solution concentrated to a small volume, sulphuric acid was added, and the gypsum crystals—after being collected by filtering through a rubber funnel—were ignited and weighed as $CaSO_4$. The filtrate was concentrated in a platinum dish, and gently ignited to drive off all hydrofluoric acid and the excess of sulphuric acid. The residue was dissolved in hydrochloric acid, a basic acetate precipitation of a part of the beryllium and phosphoric acid was made in the cold with ammonium acetate, and a little calcium precipitated from the acetic acid filtrate by ammonium oxalate, which was ignited and weighed as CaO. The beryllium in the filtrate from calcium oxalate was precipitated as a phosphate by means of ammonia, filtered, and the phosphoric acid in the filtrate precipitated with magnesia mixture. The two precipitates containing the beryllium as phosphate (the basic acetate precipitate contained the bulk of the beryllium) were ignited in the same crucible and fused with sodium carbonate. The fused material was soaked out in water, phosphoric acid obtained in the solution by the usual method, while the insoluble beryllium oxide was dissolved in hydrochloric acid, precipitated with ammonia, weighed, and the trace of P_2O_5 contained in it separated with ammonium molybdate. The P_2O_5 and bases in analysis III., on which we place the greatest confidence, were separated and determined in the above manner.

Other determinations are given to show the accuracy of the method. The CaO in II. was all obtained in the filtrate from the basic acetate precipitation, and was not partially precipitated as gypsum. The BeO in the same analysis was tested for Al_2O_3, but not more than a questionable trace could be detected. The P_2O_5 in I. was from a direct determination with ammonium molybdate, but a very slight mechanical loss was incurred. The fluorine was determined in III. by driving off the silicon fluoride and titrating the hydrofluosilicic acid by means of a standard alkali.* After making the determinations fresh U-tubes were connected with the apparatus and the aspiration carried on for several hours, but no more silicon fluoride was driven off. As our alkali had just been standardised by means of sodium carbonate and test experiments on fluor-spar, we feel very confident that the fluorine determination is correct. The water determinations are somewhat surprising. Mackintosh† made no tests for water, and considered the mineral to be an anhydrous phosphate with fluorine. Winkler‡ made no determination of fluorine, and obtained no satisfactory tests for that element by etching glass. He obtained a loss by ignition, however, of 6·59 per cent in the Stoneham mineral by strong ignition, which he regards as water. Genth§ obtained 6·04 per cent of fluorine by direct determination, and 0·61 per cent of water by heating the mineral with lead oxide to bright redness. Mackintosh‖ obtained good tests for fluorine by etching, and found a loss of 6·03 per cent by strong ignition. He proved conclusively that fluorine was given off by strong ignition, and concludes that it is replaced, in part at least, by oxygen. We are scarcely willing to believe that such a reaction would take place on heating an anhydrous phosphate containing fluorine. Our first water determination was made by weighing out the mineral in a boat, placing it in a combustion-tube containing a layer of dry sodium carbonate, igniting the tube to full redness, and collecting the water in a weighed chloride of calcium tube. We obtained 0·69 per cent; afterward the mineral was dissolved, and analysis II. completed from the same material. After almost completing our analysis, and finding only 5·27 per cent of fluorine, we tried the following experiments. A little herderite powder was placed in a hard glass tube, sealed at one end, and ignited. At first only a slight film of water condensed in the cold part of the tube; by strong ignition over the blast lamp, however, there was a sudden evolution of hydrofluoric acid, which etched the glass very perceptibly near the mineral and deposited a film of silica and very acid water, as marked as in an ordinary reaction for fluorine in a closed tube with acid sulphate of potash. In our experience we have never seen any hydrous fluoride which gives off such strongly acid water and such a marked fluorine reaction. Some of the powdered mineral was placed in a closed glass tube, covered with a layer of dry sodium carbonate, and strongly ignited; neutral water was given off and condensed as a ring, which indicated more than a trace of water. The water was obtained in the following way:—About 2 grms. of calcite were ignited over the blast lamp till a constant weight was obtained. The mineral was then weighed into the same crucible, the lime was slaked with water, the contents of the crucible were carefully dried and then ignited till constant weight was obtained, the water being calculated from the loss of weight. The slaking of the lime makes an intimate mixture of the mineral with the lime, and a preliminary experiment proved to us that only neutral water was driven off. In I. there was a slight mechanical loss in slaking the lime, which caused the water determination to be too high, the P_2O_5 too low. In III. the water was obtained from a larger quantity of mineral. No sublimate was formed on the cover of the crucible by the volatilisation of any fluoride. The analyses were made on air-dry powder

* From the *American Journal of Science*, vol. xxxii., p. 107.

* *Amer. Chem. Journal*, i., 27.
† *Amer. Journ. of Science*, III., xxvii., 135.
‡ *Neues Jahrbuch für Mineralogie*, 1884, ii., 234.
§ *Proc. Amer. Phil. Society*, xxi., 1884, 694.
‖ *Amer. Journ. of Science*, III., xxviii., 401.

which lost 0·10 per cent by drying for one hour at 100° C. The beryllium precipitates were always of a light cream-colour after ignition, indicating that not more than a minute trace of iron was present.

The following quantities of mineral were used in making the analyses:—I. 0·4552 grm.; II. 1·0029; III. P_2O_5 and bases 0·7336, F 0·9692, H_2O 1·1612.

	I.	II.	III.	Ratio.			Calculated.
P_2O_5	43·47	—	43·74	0·308		1·00	43·83
BeO	—	15·28	15·51	0·620		2·01	15·44
CaO	—	33·61	33·67	0·601		1·95	34·57
F	—	—	5·27÷38	0·138	0·343	1·11	5·86
H_2O	4·37?	—	3·70	0·205			2·77
			101·89				102·47
O equivalent of F..			2·22				2·47
			99·67				100·00

The ratio of $P_2O_5 : BeO : CaO : (F_2+H_2O) = 1 : 2 : 2 : 1$ nearly. The high temperature at which the water is driven off indicates that it is not water of crystallisation, but is very firmly united in the mineral as hydroxyl, every H_2O representing two hydroxyl groups, and the OH being probably isomorphous with F. The ratio of F : OH is nearly 1 : 1, or more nearly 3 : 4 in our analysis. In the calculated analysis we have used the ratio F : OH = 1 : 1, but recognise that it is probably simply a case of isomorphism. The composition of herderite is, therefore, an isomorphous mixture of $CaBeFPO_4$, with $CaBe(OH)PO_4$, which may be written $CaBe(FOH)PO_4$, or a salt of phosphoric acid, two of whose hydrogen atoms have been replaced by a bivalent element, and the third likewise by a bivalent element whose other free affinity has been satisfied by a fluorine atom or hydroxyl. This is the same composition as that proposed by Mackintosh, except that he regarded the mineral as simply the fluorine compound, and did not detect the water. Chemically herderite is closely related to the three minerals—wagnerite, triplite, and triploidite—whose compositions are respectively Mg_2FPO_4, $(FeMn)_2FPO_4$, and $(FeMn)_2(OH)PO_4$. These three minerals offer the best illustration we have of the isomorphism of F and OH, and we feel that we have in herderite another strong proof of the correctness of this interesting relation. In crystallisation the minerals vary, herderite being orthorhombic, triplite questionable, and wagnerite and triploidite monoclinic. The latter two have, like herderite, a prismatic angle of nearly 120°.

2. *Analysis of Beryl.*

In 1884 one of us* published a series of analyses which showed that alkalies are present in beryl sometimes to quite a large extent, and that water is always given off by ignition. At the time the analyses were made the author had had little experience in the determination and separation of beryllium, and used the ammonium carbonate method, which seemed to him to be the most accurate. Our experience has taught us that the method used in the manner described in the above-mentioned article gives too low results for beryllium, and the analyses are only of value as showing to what extent alkalies and water are present in beryl. Since the publication of the article it has always been the author's wish to make a series of experiments on the separation of aluminum and beryllium, and renew the investigation.

We have considered it best not to make a long series of beryl analyses, but to select some very pure beryl and make an analysis of it as carefully as possible. The analysis was made according to the method described at the end of this article, and we feel assured from our experience that the results of the analysis represent the composition of the mineral very closely. The beryl which we selected for analysis was a very pure transparent aquamarine from Stoneham, Maine, furnished to us by Mr. George F. Kunz, of New York. The mineral was crushed and ground in a steel mortar, and the fine powder boiled in dilute hydrochloric acid, washed, and dried at 100° C. Duplicate analyses were made by both of us, so that we might obtain a very fair average.

Specific gravity, taken on a chemical balance, 2·706.

		Ratio.		
SiO_2	65·54	1·092		6·00
Al_2O_3	17·75	0·172	0·173	0·95
Fe_2O_3	0·21	0·001		
FeO	0·38	0·005		
BeO	13·73	0·541	0·558	3·06
CaO	0·06	0·001		
Na_2O	0·71	0·011		
Li_2O	trace			
H_2O	2·01	0·112		0·61
	100·39			

The ratio of $SiO_2 : Al_2O_3 : RO : H_2O = 6 : 1 : 3 : 5$ nearly. The ratio of the first three is in the proportion required by the usually accepted formula for beryl. This conclusion was also arrived at by Baker* in a recent analysis made according to the same method which we used. As regards the alkalies, we have as yet no proof that they replace the beryllium, but that is probably the case. Analyses of beryls very rich in alkalies would best settle this question. The water is very constant, about 2 per cent, in all beryls which have come to our notice, with one exception,—Aduntschilon, Siberia,†—and must be in some way very firmly united in the molecule, as it is only given off by very strong ignition. As can be seen by our ratio, there is about one-half a molecule present. Beryls which show a higher percentage of water may, and in some cases which have come under our observation do, contain mechanical inclusions of water. Regarding the water as essential, we would have to add $\frac{1}{2}H_2O$ to the ordinary accepted formula of beryl, or write it $H_2Be_6Al_4Si_{12}O_{37}$. The theoretical composition according to the above formula is—

SiO_2	65·81
Al_2O_3	18·83
BeO	13·71
H_2O	1·65
	100·00

We can add also the alkali determinations in the following European beryls. The alkalies were determined by Smith's fusion method and calculated as sodium, although they all contained some lithia. Limoges, France, 0·73 per cent; Hühnerkobel near Bodenmais, Bavaria, 1·20 per cent; Habachthol, Tyrol, 2·26 per cent.

3. *On the Precipitation and Washing of Aluminum.*

Before making the above investigations we tried a few experiments in the precipitation and handling of aluminum precipitates, which may be of interest to some of our readers. A standard solution of aluminum chloride was first made, containing 0·1002 grm. Al_2O_3 and 1 c.c. pure concentrated HCl in every 50 c.c. which were used in our experiments. The precipitation of the alumina wasin all cases made in a volume of about 300 c.c., by neutralising the solution with ammonia till the odour of ammonia could be distinctly obtained from the hot solution; the beaker was then placed upon a lamp-stand and the solution brought to boiling, which was not continued more than one minute. The precipitates were in all cases washed without a pump, but suction-tubes 7 inches long were attached to the funnels, which cause a gentle suction, and if the filter-papers are carefully fitted to the funnels very materially hasten the filtration.

* S. L. Penfield. *Amer. Journ. of Science*, III., xxviii., 25.

* *Amer. Chem. Journ.*, vii., 175.

† *Amer. Journ. of Science*, III., xxviii., 29.

The following facts were observed: that precipitates which were made in solutions containing large quantities of acid, either hydrochloric or nitric, filtered as well or better than those from solutions cotaining little ammonia salts, but on washing with boiling water the precipitates from solutions containing large quantities of ammonia salts became very sticky, washed slowly, so that it was almost impossible to free them from the last traces of ammonium chloride; and that very perceptible quantities of alumina settled out from the filtrates and washings on adding a few drops of ammonia and allowing the beaker to stand in a warm place. Further, that all of the alumina which ran through did so during the washing. The precipitates after they had become slimy and sticky seemed either to be quite soluble in the hot water or else got into such a condition that they readily passed through the pores of the paper and stopped them up, thus hindering the filtration. To make a successful precipitation and washing of alumina it is quite essential not to have very much ammonia salts present, and even with the greatest care it is found that if the filtrates and washings are set away in a warm place, slight precipitates will almost invariably settle out. The above holds good for solutions containing ammonium chloride and nitrate. The fact that alumina passed through the filter only during the washing suggested to us that if we could wash the precipitate with a saline solution which would be completely volatile and do no harm to the precipitate we might avoid the passage of the alumina through the filter and it might also hinder the packing of the precipitate. Ammonium nitrate suggested itself to us as a salt which would be volatile on ignition and do no harm, and our experiments with it have been very satisfactory. The following strength of NH_4NO_3 has been used in all of our experiments—2 c.c. of pure concentrated HNO_3 neutralised with ammonia and diluted to 100 c.c. with water; this strength has proved so satisfactory that we have tried no other. Using this hot saline wash instead of hot water the precipitation can be made in solutions containing large or small quantities of ammonium salts, and no very great care is needed in adding the ammonia. According to our experience, the precipitates from solutions containing a goodly quantity of ammonia salts, resulting we will say from 4 to 8 c.c. of pure concentrated hydrochloric or nitric acid, filter and wash better than precipitates from solutions containing less saline matter. After having made a large number of precipitations we can say that only in one or two cases have we found a trace of alumina in either the filtrate or washings, and that unless the precipitate becomes too dry and packs too firmly upon the sides of the funnel, the washing goes on as well at the end as at the beginning, and there is no difficulty in washing the precipitate free from all traces of chlorine.

Where large quantities of sodium or other fixed salts are to be removed and a second precipitation of the alumina is required, we recommend that the first precipitate after washing be dissolved in nitric instead of hydrochloric acid, then very little washing is enough to free the second precipitate from the last traces of chlorine and fixed salts.

Why ammonium nitrate acts in this way we are not able to state. It may be something on the same principle that sediment deposits much faster in saline than in fresh water. We are convinced that any one who has to handle troublesome alumina precipitates will find the above method of washing of great advantage.

(To be continued.)

On the Combinations of Chloral and Resorcine.—H. Causse.—In the action of chloral upon resorcine there are formed two series of products; the one crystalline, derived from a molecular combination, and the other amorphous, representing a combination of a polymer of chloral with a polymer of resorcine.—*Comptes Rendus*, vol. ciii., No. 5.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JULY 31ST, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, August 6th, 1886.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 1st to July 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 189 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

Altogether, the water supply for the past month has maintained the satisfactory character which it has now exhibited uninterruptedly for some time past. The mean proportion of organic carbon in the Thames-derived supply was 0·140 part in 100,000 parts of the water, as against a mean of 0·152 part in the preceding month's supply.

In carrying out the bacteriological inquiry, of which we gave an introductory notice in our last monthly report, one of our earliest series of experiments, in which we aimed more especially at simplifying the conditions as much as possible, was made with sterilised distilled water, infected with about $\frac{1}{1000}$th of its bulk of peptone-fluid loaded with an active sporeless growth of the splenic fever bacillus. This addition of peptone-fluid to the water operated on, besides furnishing an abundance of the morbific micro-organism which formed the special subject of the experiment, necessarily effected a considerable charging or pollution of the water with animal and other organic matter, besides adding to it an almost insignificant quantity of saline or mineral matter. Calculated from the percentage of nitrogen present in the dry peptone, the proportion of organic nitrogen in the purposely infected distilled water could not have been less than 2 parts in 100,000, or about forty times the proportion commonly met with in the Thames-derived supply of the Metropolis. In so far, accordingly, as the presence of nitrogenous organic matter is concerned, the water experimented on was, as compared with Thames water, in a condition eminently favourable to the continued life and growth of the introduced microbe.

Seven experiments in all were made with distilled water infected as above described, and were set going on seven different days from March 9th to March 24th inclusive. One of the experiments was made in quadruplicate, and the other six in duplicate. Each experiment involved the sowing of from four to twelve tubes of sterilised culture-fluid with the infected water, or a total of more than fifty sowings, and of course an indefinite number of observations, from time to time, of the results of each particular sowing. The infected water was kept at the temperature

of the air of the room, which on different occasions varied from 56° to 59° F. (13·5° to 15° C.). The tubes of culture-fluid sown with the infected water were kept for several days in an incubator at the uniform temperature of 90° F. (32° C.). It was observable, however, that when a development of bacillus in the culture-fluid did not become apparent within from 18 to 24 hours, it did not manifest itself after any longer incubation.

The general result of this series of experiments was as follows:—The culture-fluid, when sown with some of the infected water within two hours of its having been infected, invariably exhibited on incubation an abundant and characteristic growth of the bacillus, from which further growth could be set up indefinitely. The same culture-fluid when sown with the infected water from three to four hours after its infection, furnished irregular results on incubation. Sometimes there was, and sometimes there was not, more or less bacillar growth of the ordinary character; while in some cases what growth there was, much or little, put on a peculiar fluffy appearance, very different from the usual appearance of *bacillus anthracis* culture, and might, it was thought, not improbably (?), possess only an attenuated morbific activity. When the sowing, however, was with distilled water which had been infected five or six hours previously, or from that up to forty-three hours previously—beyond which lapse of time the experiment was not continued—the culture-fluid invariably remained unaffected on incubation, or the addition of the at one time infected water was found to be barren of any results; showing that in the case of distilled water, despite the comparatively large proportion of nitrogenous organic matter added, the introduced bacillus was not able to undergo development, or to maintain its existence for more than a few hours.

The above-described series of experiments made with sterilised distilled water was followed up by a series of analogous experiments made with sterilised Thames water, the more or less similar results afforded by which we proposed to give some account of in our next monthly report.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

ON CERTAIN EOCENE FORMATIONS OF WESTERN SERVIA.*

By Dr. A. B. GRIFFITHS, F.R.S. (Edin.), F.C.S. (Lond. and Paris), Head Master and Lecturer on Chemistry, School of Science, Lincoln.

These formations (consisting of shale containing paraffin wax and clay) are situated near the River Golabara in the West of Servia. The shale occurs in upheaved cliffs about 200 feet above the surrounding plains. The formations consist (according to the geologists and engineers who have inspected it) of hundreds of layers of white and grey shale one above the other, sometimes being separated by small beds of clay of a whitish colour containing rock-salt (or "*beds of fossil salt*," as Lyell liked to call it). The extent of this geological formation is very great, extending, as at present discovered, unbroken over 30 square miles of country. The layers of shale are foliated almost like sheets of paper, this being due to the great pressure they have been subjected to during their formation or subsequently. I am given to understand the whole territory in this part of the world strongly resembles the paraffin and salt districts of Galicia. The Servian shales are rich in paraffin and have remained unobserved until about two and a half years ago, but it has been known for "ages" that cattle, birds, and other animals have been in the habit of resorting to these cliffs and eating the clay containing the rock-salt. This paraffin shale is entirely free from bituminous impurities and is of a nearly white colour; it has no odour.

It is very difficult to say what is the origin of the paraffin in these deposits, but most likely it is of vegetable origin*, having been produced from a natural distillation of the old brown coals which abound in the vicinity of the deposits. The author has conducted a series of careful chemical analyses upon specimens of the rocks of this part of Servia.

A sample of the paraffin shale yielded on distillation at 70° C. a semi-solid hydrocarbon; this semi-solid yields, on treating with "benzoline" 1·75 per cent of wax (a solid paraffin) and 0·25 per cent of hydrocarbon oils. What remains are the mineral constituents of the shale *plus* a carbonaceous matter containing nitrogen. On incineration this residue (contained in the retort) yields 92·04 per cent mineral matters of the original weight of the paraffin shale taken for analysis. The complete analysis stands as follows:—

(I.) *Paraffin Shale.*

2·00 per cent	Semi-solid hydrocarbon distils over at 70° C.	= 1·75 per cent wax.	
		= 0·25 „	hydrocarbon oils of the $C_n H_{2n+2}$ series.
3·02 „	Water of combination.		
2·94 „	Carbonaceous matter containing nitrogen.	= (yields) 1·18 per cent Ammonia.	
92·04 „	Mineral Matters (Analysis given below).		
100·00			

II. *Analysis of Mineral Constituents of a Servian Paraffin Shale.*

Alumina (Al_2O_3)	32·86 per cent.
Iron Oxide (Fe_2O_3)	5·20 „
Magnesia (MgO)	1·26 „
Lime (CaO)	1·21 „
Potash (K_2O)	2·17 „
Soda (Na_2O)	0·41 „
Silica	56·85 „
Loss	0·04 „
	100·00

The old brown coals of the neighbourhood (which contain more or less rhombic iron pyrites (Marcasite, frequently in rather large macles), gave on analysis:—

	I.	II.
Carbon	49·2 p.c.	49·3 p.c.
Hydrogen	1·1	1·2
Water (chemically combined)	30·2	30·5
Water (hygroscopic)	19·5	19·0
	100·0	100·0

* Read before the Geological Society of London, June 23, 1886: communicated by Prof. J. W. Judd, F.R.S., P.G.S., &c.

* See Dr. Griffiths's paper "On the Occurrence of Phenol in *Pinus sylvestris*; A Discovery bearing on the Flora of the Carboniferous

The quantity of ash contained in these coals is between 5 and 7 per cent, and consists chiefly of alumina, lime, magnesia, iron oxide, and silica. Eruptive porphyry and trachytic rocks are plentiful at a distance of five or six miles from the deposits. The shale deposits are of marine origin and of the eocene period. The eruptive rocks just alluded to protude into these deposits and are of a later date than the deposits themselves.

Samples of the eruptive porphyry and trachytic rocks gave on analysis the following compositions:—

(I). *Eruptive Porphyry.*

Alumina (Al_2O_3)	18·10 per cent.
Iron Oxide (Fe_2O_3)	2·69 ,,
Manganous Oxide (MnO)	0·82 ,,
Lime (CaO)	0·36 ,,
Magnesia (MgO)	0·12 ,,
Potash (K_2O)	1·23 ,,
Soda (Na_2O)	0·16 ,,
Silica (SiO_2)	75·51 ,,
	99·99

(II.) *Trachytic Rocks.*

Alumina (Al_2O_3)	20·82 per cent.
Iron Oxide (Fe_2O_3)	5·03 ,,
Manganous Oxide (MnO)	0·01 ,,
Lime (CaO)	1·98 ,,
Magnesia (MgO)	0·51 ,,
Potash (K_2O)	7·03 ,,
Soda (Na_2O)	3·10 ,,
Phosphoric Acid (P_2O_5)	0·03 ,,
Silica (SiO_2)	61·49 ,,
	100·00

The clay beds of this part of the world contain large numbers of the genera Ostrea, Cerithium, Cyrena, Nautilus, and Voluta; with the fossil remains of the vertebrata which lived in the Eocene Seas, &c.

These remains consisted principally of the Teleostean and Placöid fishes, the former predominating considerably. I may say, in passing, *no* horned hoofed mammals have so far been discovered in these Servian deposits corresponding to Professor Marsh's Dinocerata of the Eocene deposits of America.

It may be that during the Eocene period in Europe the climatic conditions were not suited for the thirty or more species of Eocene Dinocerata mammals which lived in the New World during these geological times.

The clays of the districts in question from which the shales were originally formed contain innumerable microscopic siliceous shells of marine Diatomaceæ with calcalcareous shells of Foraminifera (principally of the genus Nummulites); and it is supposed to be similar to the ooze now forming at the bottom of the Atlantic and other oceans. From the structure of the formations and other considerations it is thought that in the limestone rocks which underlie these shale deposits, rock-salt and petroleum wells will be found; and it is highly probable that all the deposits of the district are more or less of organic origin (limestones, shales, brown-coal, paraffin, &c.) or in the words of the poet Byron:—

"The dust we tread upon was once alive."

Further, the engineers who have inspected the district say that the shale can be extracted by open quarrying at "the cost of a few pence per ton"; and that in distilling the shale on the spot now that gas-retorts are in use the shale itself can be utilised as fuel. These formations are situated in easy access of the Rivers Sava and Danube.

Epoch and the Formation of Petroleum," Chemical News, vol. xlix., p. 95; *Berichten der Deutschen Chemischen Gesellschaft* No. 6, 1884 p. 171; and *Chemiker Zeitung*, vol. viii., p. 342.

EMBOLITE: ITS COMPOSITION AND FORMULA.

By CUTHBERT WELCH.

In the Chemical News, vol. liii., p. 99., Mr. J. M. H. Munro gives an analysis of embolite from St. Arnaud, Victoria, claiming for the mineral, on the strength of this analysis together with one by Mr. C. Wood, the simple formula AgCl.AgBr. During a mineralogical study of the ores of silver my attention has once more been drawn to the composition of this ore, a subject which has on several previous occasions interested me. Can it be regarded as a single mineral with rather large variations in composition, or rather as an indefinite mixture of hornsilver and bromite? The latter view appears to me to be the more probable, for of 14 analyses (being all of which I have any record) 4 agree closely with AgCl.2AgBr, 2 with 5AgCl.2AgBr, 7 call each for a separate formula, and only 1 agrees with the equimolecular formula AgCl.AgBr, although this is usually quoted as representing the composition of embolite. It is also worthy of notice that the specimen yielding this simple formula is from Victoria, whilst no single specimen from Chili has agreed with it, although by far the greatest amount of this ore is derived from the latter country.

In proof of the above I append these 14 analyses arranged according to their composition, with the authority upon which I quote each:—

I. AgCl.AgBr.

C. Wood, from St. Arnaud. ("Goldfields and Mineral Districts of Victoria," by R. B. Smyth, F.G.S., p. 411. 1869).

		Theory.
AgCl	43·23	43·288
AgBr	56·77	56·712
	100·00	100·000
	Or,	Or,
Ag	65·14	65·159
Br	24·16	24·136
Cl	10·73	10·705
	100·03	100·000

II. AgCl.3AgBr.

F. Field, from Chanarcillo, Chili. (*Quarterly Journal of Chemical Society*, x., p. 239. 1858). Very dark green, sometimes of a rich purple colour.

		Theory.
AgCl	20·52	20·297
AgBr	79·48	79·703
	100·00	100·000
	Or,	Or,
Ag	61·07	61·063
Br	33·82	33·916
Cl	5·00	5·021
	99·89	100·000

III. 2AgCl.AgBr.

F. Field, from Chanarcillo, Chili. (*Quarterly Journal of Chemical Society*, x., p. 239. 1858). Pale green colour.

		Theory.
AgCl	60·43	60·422
AgBr	39·57	39·578
	100·00	100·000

		Or,	Or,
Ag	.. .. ..	68·22	68·212
Br	.. .. ..	16·84	16·841
Cl	.. .. ..	14·92	14·947
		99·98	100·000

IV. 2AgCl.3AgBr.

W. von Beck, from silver mines in the Troitzer Bezirk, Orenberg. (*Jahrbuch für Mineralogie*, 1876, p. 165). In minute octahedrons and in thin crusts.

			Theory.
AgCl	.. .. ..	33·17	33·725
AgBr	.. .. ..	66·83	66·275
		100·00	100·000
		Or,	Or,
Ag	.. .. ..	63·35	63·455
Br	.. .. ..	28·44	28·202
Cl	.. .. ..	8·21	8·343
		100·00	100·000

(To be continued).

NOTICES OF BOOKS.

The Techno-Chemical Receipt Book. By WILLIAM T. BRAUNT and WILLIAM H. WAHL, Ph.D. (Heid.) Philadelphia: Henry Carey Baird and Co.; and London: Sampson Low, Marston, Searle, and Rivington.

THE title of this book is rather misleading, the contents being of a much more general character than we should expect. The part which is headed "Chemical and Techno-Chemical Expedients, Preparations," comprises only five pages out of a total of 460, and amongst them we find a receipt to "thaw frozen ground" by means of putting snow and unslaked lime over it; this seems hardly to come under the above named heading. There is, however, a very large amount of exceedingly useful information in the book, the receipts comprising a wide range of subjects, such as making artificial eyes, cleaning gloves, making fulminates, poisoning rats, mixing paints, and many more of as varying a character. The principal subject headings are all in alphabetical order, thus rendering it an easy matter to find anything that is in the book, while there is at the end a copious index. The utility of such a book of reference for nearly every trade is beyond all question, and we wish the authors every success.

CORRESPONDENCE.

DISCUSSION ON THE NATURE OF SOLUTION.

To the Editor of the Chemical News.

SIR,—It may, perhaps, be convenient to those chemists who have announced their intention of joining in the proposed Debate in Section B at the approaching meeting of the British Association that, having accepted the invitation of the President to open the discussion, I should indicate briefly the general nature of the subjects upon which I shall offer some remarks, and the order in which I shall probably take them.

After a historical sketch of the theories which have been framed with the object of explaining the constitution of saline and other solutions, the phenomena of solution will be dealt with somewhat as follows:—

Thermal and volume changes occurring in the act of solution and their mutual relations. How far and under what circumstances are thermal and volume changes to be considered as indicating chemical change?

The molecular volumes of salts in solution. The specific heat and vapour pressures of salt solutions.

The relation of solubility to molecular volume, to fusibility, and to the composition of the liquid.

Action of solids, and especially of porous bodies, on solutions.

Phenomena of supersaturation.

What is chemical combination, and is there any criterion by which it may be distinguished from adhesion or mechanical combination.

In consequence of the very wide reaching character of the subject it will not be possible to take up the question of solution except as relating chiefly to solids, and especially salts, in water. For the same reason I cannot fully discuss the phenomena of absorption spectra, nor generally the action of solutions upon light, but I hope some of those chemists who have worked on this part of the subject will be present and will give us the benefit of their experience.

There will of course be a great number of questions incidentally touched upon in my opening, which may well form the basis of remarks from other speakers, such as:—

How is saturation to be explained, *i.e.*, why is there generally a limit to solubility?

Is there any general connection between solubility and atomic weight in a series of compounds in which only one constituent varies?

What becomes of water of crystallisation when a salt containing water is dissolved in water?—I am, &c.,

WILLIAM A. TILDEN.

The Mason College, Birmingham,
August 12, 1886.

MAGENTA *v.* FUCHSINE.

To the Editor of the Chemical News.

SIR,—I am surprised and sorry to find that my protest against the kakophonous and un-English term "fuchsine" should incur the disapproval of Mr. A. H. Allen. I do not deem it necessary to take up your space by recapitulating all the objections to fuchsine. In the first place it is misleading. From analogy, when we see the termination "ine" appended to the name of a plant, or part of such name, we expect a proximate principle obtained from the plant in question. Hence such names as fuchsine, azaleine, roseine, geranosine, helianthine, &c., are to be condemned. It would not be difficult to find among fuchsia flowers twenty tones which could not be dyed with magenta at all, especially without the admixture of other colouring-matters. Lastly I must point to the custom of trade. Dyers, tissue printers, and the authors of works intended for their use, call the commercial salts of rosaniline "magenta," and if they mention "fuchsine" at all make it rank as a mere synonym. I may give as instances Benedikt and Knecht's "Chemisty of the Coal-Tar Colours," Hummel's "Dyeing of Textile Fabrics." Crace-Calvert's "Dyeing and Calico Printing," &c. If we are to use fuchsine in preference to magenta we may as well discard the English names cudbear, turmeric, and annatto in favour of persio, curcuma, and Orleans.—I am, &c.,

YOUR REVIEWER.

On the Hydrates of Zinc Chloride.—R. Engel.—There exist three hydrated zinc chlorides containing respectively 3 and 2 mols. of water to 1 mol. of the anhydrous chloride, and 3 of water to 2 of the anhydrous compound.—*Bull. de la Soc. Chim. de Paris.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 5, August 2, 1886.

On the Displacement of Ammonia by other Bases and on its Determination in Soils.—MM. Berthelot and André.—The authors consider it established that ammonium-magnesium phosphate is not appreciably decomposed at 100° in an hour by calcined magnesia, and very imperfectly by lime, the latter fact having been previously observed by Boussingault. Hence magnesia cannot be safely employed in the determination of ammonia in the analysis of soils and organic products containing insoluble ammoniacal double salts. Certain derivatives of the aldehyds are in the same case, and there is reason to fear the same thing for the ammoniacal salts formed by humic acid by its congeners. As to allowing the use of magnesia to be preceded either by washing the soil with dilute nitric acid until an incipient acid reaction is perceived, as M. Schlœsing not long ago proposed, or by dissolving the soils in pure hydrochloric acid, a new process which he recommends in his last memoir, these expedients suggest reservations which the present authors still maintain.

The Determination of Ammonia.—T. Schlœsing.—The author has shown in his paper of July 26 that, by distillation over magnesia, the total ammonia can be extracted from the solution of ammonium chloride or from that of ammonium-magnesium phosphate. To complete his demonstration he has caused magnesia to act upon double ammoniacal salts, especially the chlorides into which enter magnesium and zinc. He has accordingly operated upon five double salts, the ammonium-sulphates of magnesium, zinc, and copper, and the ammonium chlorides of magnesium and zinc. He finds that in all these cases the use of magnesia for the liberation of ammonia may be continued with safety.

Separation of Arsenic, Antimony, and Tin.—Ad. Carnot.—Will be inserted in full.

Formation-Heat of Amorphous Selenides.—C. Fabre.—In general the formation-heat of the selenides prepared at high temperatures is equal or slightly lower than that of the corresponding precipitated sulphides. As for the precipitated selenides, their comparison with the corresponding sulphides shows that the difference between the formation-heats of the metallic sulphides and selenides is less than the difference between the formation-heats of the alkaline sulphides and selenides.

Composition of the Portion of Suint Soluble in Water.—E. Maumené.—The author has hitherto published a small part only of the researches which he carried on in concert with the late Victor Rogelet. The memoir laid before the Academy by M. Buisine induces him to publish one of his results. He has studied the volatile products of the pyrogenous decomposition of the mixture of potassium salts extracted by water from suint. Among these he has isolated a new product, dienic ether, to which he assigns the formula C_4H_4HO. It is absolutely colourless, very mobile, boils at 36° at a pressure of 761 m.m., and has the specific gravity 2·7. It is derived from the pyrogenous decomposition of potassium lactate.

Journal für Praktische Chemie.
New Series, Vol. xxxiv., Part 1.

Researches from the Chemical Laboratory of the University of Leipzig, Communicated by E. von Meyer.—These communications consist of a paper by V. K. Voigt on the action of primary aromatic amine upon benzoin and a memoir by A. Pfungst on the action of nitromethan upon certain chlorhydrines.

Contributions to the Chemistry of Manganese and of Fluorine.—O. T. Christensen.—Nicklès has formerly stated that manganese tetrachloride is formed by the action of ether containing hydrochloric acid upon manganese peroxide. The author has succeeded in showing that the ethereal solutions with which Nicklès operated contain only Mn_2Cl_6. The action of hydrofluoric acid is similar. The atomic weight of fluorine has been found to be 18·9 (H = 1) or 18·99 if O = 16. On the electrolysis of a solution of Mn_2F_6 in hydrofluoric acid there is formed at the positive pole, if it offers a large surface, abundance of permanganic acid. The reaction is so well marked that even traces of a salt of manganese, if dissolved in aqueous hydrofluoric acid and exposed to the current, show almost instantly the violet-red colour of permanganic acid at the margin of the liquid. The reaction succeeds best if the platinum capsule with the liquid is made to serve as the positive electrode. On heating the double manganese double fluorides, especially that of the double sodium salt, in a platinum tube in dry pure oxygen or nitrogen, there appears at first a little of another gas, possibly fluorine, which liberates iodine from solid potassium iodide and bromine from potassium bromide. Afterwards the tube becomes porous and the combustion products of the gas penetrate the pores, forming hydrofluoride.

Arabonic Acid and a Sugar formed from Lichenin.—R. W. Bauer.—The author has previously shown that arabonic acid is formed on oxidising arabinose with bromine, and that it is distinguished from gluconic acid by the solubilities of its cadmium salt. The composition of arabonic acid is represented by $C_6H_{10}O_6$. Its melting point is 89°. The sugar obtained from lichenine immediately after solution showed a polarising power of +50°; a day subsequently, as the mean of several observations, +28·5°.

Condensation of Formaldehyd.—O. Loew.—Some time ago the author reported on the formation of a sugar from formaldehyd, the condensation process being mediated by calcium hydroxide. The observation that the condensation is possible in a simply watery solution may be of some interest in vegetable physiology. The condensation ensues the more readily the more dilute the formaldehyd. A sugar was obtained on boiling 5 per cent solution of formaldehyd for twelve to fifteen hours with granulated zinc (or preferably granulated tin) in a cohobator. In this latter case there is a catalytic action concerned. The quantity of tin must be considerable, which speaks in favour of surface action. Neither copper nor mercury can be used in place of tin. This process has evidently the greatest resemblance to those which occur in plants. Here also the question often solely a transfer of conditions of movement (from the *living* protoplasm) to the material selected for the theses or scissions. The great physiologist Ludwig was perfectly right when he said: "A large portion of physiological chemistry may easily become a part of catalytic chemistry."

Reply to H. F. Stohmann.—Julius Thomsen.

Conclusion of the Polemics with H. Thomsen.—Stohmann.—A discussion on Prof. Thomsen's method of conducting his thermo-chemical experiments, which seems in danger of degenerating into a quarrel.

Die Chemische Industrie.
Vol. ix., No. 5, May, 1886.

The Influence of the Presence of Arsenic on the Specific Gravity of the ordinary Oil of Vitriol of Commerce.—Dr. R. Kissling.—Whilst a pure sulphuric acid containing 93·64 per cent. of monohydrate has

gr. 1·8360, a sample of arseniferous acid, containing 60 per cent. of the monohydrate and 0·254 of arsenious d marked 1·8413.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxiii., Part 3.

Researches on the Physical Properties of Liquid pounds.—These investigations include memoirs on boiling-points and the specific volumes of the normal ers of fatty acids, by Dr. R. Gartenmeister, and on ic volume and specific volume by W. Lossen.

mmunications from the Chemical Institute of University of Bonn.—This consists of the first part memoir by R. Anschütz and E. Romig on the action tric acid upon unsymmetrical diphenylethan.

mmunications from the Chemical Laboratory of University of Moscow.—These comprise a paper Orloff on hexylglycerin from allyl-dimethyl-carbinol, memoir by A. Siwoloboff on the dichlorhydrine of ite and its reduction.

termination of the Carbon, Hydrogen, and Nitro- of Organic Compounds by a Single Combustion. Jannasch and V. Meyer.—The combustion of the is effected in the ordinary manner in a combustion with copper oxide and a layer of copper spirals. The connected in the front in the ordinary manner with lcium chloride tube, a potash apparatus, and a special gement for collecting the nitrogen. At the back it wn out to a point. The entire combustion is exe- in an atmosphere of pure oxygen, which, the commencement of the operation, has entirely d the air out of the apparatus, just as this is done mas's method by means of carbonic acid. But, in the latter case the nitrogen gas is collected over -ley, the authors collect it over a solution of chro- chloride, which is an excellent absorbent for oxygen. rrent of pure oxygen was obtained from a mixture assium dichromate and permanganate.

Vol. ccxxxiv., Part 1.

Derivatives of the Chlorinised Paranitro- s.—A. Kollrepp.—This extensive memoir does not of useful condensation.

mmunications from the Laboratory of Prof. J. enus.—These consist of a memoir, by C. Rach, on ion of nascent hydrocyanic acid upon acetsuccinic- nd a paper by C. A. Bischoff and C. Rach on yrocinchonic acid.

Aromatic Hydrocarbons of the Caucasian l Oil.—W. Markownikoff.—The raw material the naphtha from the Balachary plain, in the a Apscheron, near Baku. Among the products d in the fractions boiling between 85° and 250° are toluol, isoxylol, pseudocumol, mesitylene, durol, , diethyltoluol and its isomers, and at least four arbons of unknown structure. The portion boiling contains only homologues of the benzol series. this temperature there occur compounds of the C_nH_{2n-8}, and from the higher distillates there are compounds still poorer in hydrogen. The l nature of these latter has not been accurately ined, but those compounds of the series C_nH_{2n-8}, $_{-10}$, and C_nH_{2n-12}, which the authors had in their , can certainly not rank with the so-called non- ted hydrocarbons, whose representatives are found rol, phenylacetylene, &c. The inability of the arbons obtained to unite directly with halogens he authors to suppose that they are representatives e new series.

stigations on the Pyridin-Carbonic Acids.— ner.—The author has subjected chenolic and nicotic pyridin-tricarbonic and cinchomeronic acid to the action of methyl-iodide. He finds that all these four acids undergo modifications even at 100° in presence of methylic alcohol. Nicotic acid alone leads to methyl ammonium iodide; chinolic acid splits off carbonic acid and yields nicotic methyl-iodide. The experiments with pyridin-tricarbonic acid and cinchomeronic acid led to the synthesis of apophyllenic acid.

Journal de Pharmacie et de Chimie.
Series 5, Vol. xiv., No. 1, July 1, 1886.

Wine of Rice.—M. Busgen.—This strongly alcoholic liquor is in great esteem in all the eastern portion of Asia. Its fermentation is effected by a fungus known as Aspergillus orizæ.

Determination of Acid Magenta, Bordeaux Red, and Soluble Red in Wines.—J. Bellier.—The author states that his experiments are quite conformable to those of M. Sambuc. His method reposes on the use of a mixture of mercuric acetate, dry and powdered, and of calcined magnesia; 84 parts of the former ingredient, with 16 of the latter, gave the best results. Fifty c.c. of the wine were raised to a boil in a porcelain capsule; the powder was added, and the liquid, after stirring, was filtered into a 100 flask containing 2 c.c. of sulphuric acid with a little water. The precipitate was then washed so as to make up the filtrate to 100 c.c. The liquid was then compared colorimetrically with an aqueous solution of acid magenta. The determination of Bordeaux red and soluble red is effected in a similar manner, but as a certain quantity of the colouring matter is fixed energetically upon the filter it must be dissolved with alcohol, or preferably in ammoniacal alcohol. By the use of this method 3000 hectolitres of wine, fraudulently coloured, have been seized in one year at the various railway stations in Lyons. The author announces that he will shortly publish a method founded on an entirely different principle and applicable to a great number of colours.

On Petroleum-Ether.—V. Péquart.—The only safe method of ascertaining the purity of this product is distillation of a rather large quantity in the water-bath, raising the temperature gradually to 60° and 65°, without exceeding this point. If the receiver is then changed and the heat raised to 70° there passes over a colourless liquid of a different odour and of a slightly acid reaction. If, when nothing more passes over, the temperature is raised to 85°—90° the product of the retort becomes black and separates on cooling into two strata. The upper layer is yellowish, transparent, and slightly acid. The lower is dark brown and strongly acid.

The Organic Matter in Potable Waters.—M. Fauvel.—The author's experiments have been made according to Koch's method, which rests on the double property of gelatin as being an excellent culture-medium for bacteria, and being liquefied by the bacteria of putrescent animal matter. It was observed that the water of the canal of l'Ourcq contains fewer colonies than that of the Vanne, but yet these colonies liquefy the gelatin more rapidly. The results have been checked by chemical analysis, the organic matter being determined by means of potassium permanganate.

Resistance of Microbia to the Heat of Stoves.—Dr. Grancher.—Moist steam at a pressure of 106 centimetres was found more effective than dry steam.

Archives Neerlandaises des Sciences Exactes et Naturelles.
Vol. xx., Part 5.

The Melting-point of Ice under Pressures Lower than that of the Atmosphere.—B. J. Goosens.—To decrease in pressure corresponding to the atmosphere there corresponds a rise of temperature =0·0066°.

Bulletin de la Société Chimique de Paris.
Vol. xlv., No. 12, June 20, 1886.

Action of Oxygenated Water upon the Oxides of Chrome.—M. Martinon.—When hydrogen peroxide reacts upon chromic acid in an acid liquid there appears the blue colouration characteristic of perchromic acid. Gradually the blue colour disappears and a salt of chromium sesquioxide remains whilst oxygen is liberated. Perchromic acid is, therefore, an addition-product formed by chromic acid and hydrogen peroxide and having the composition $Cr_2O_7H_4$. This addition-product is blue in presence of acids and of a dirty red in neutral liquids. In this latter case the decomposition is more rapid. If oxygenated water is allowed to act upon chromium dioxide, as prepared by Schweitzer's process, there is formed a chromate without escape of oxygen if the liquid is alkaline. In a neutral liquid the reaction is excessively slow, but ultimately there is formed a little chromic acid. In an acid solution oxygen is given off and there is formed a salt of chromium sesquioxide. In all these cases chromium dioxide behaves absolutely like a chromate of chromium sesquioxide. In neutral or acid liquids chromium sesquioxide does not react with oxygenated water, but in an alkaline medium there is immediate formation of a chromate. This means may serve for detecting salts of chromium; it gives even in very dilute solutions of the chromic salts, especially if slightly heated, very distinct results, and may be utilised in analysis.

Little Known Cause of the Corrosion of Steam Boilers.—D. Klein and A. Berg.—The authors show that cane sugar, inverted sugar, and decoction of malt attack iron strongly, forming an acid product. Glycerin and mannite have no action. Zinc is strongly attacked with a copious escape of hydrogen. Copper, tin, and aluminium are not attacked. If lead or cadmium is heated in a sealed tube to 120° to 125° with a concentrated solution of sugar it forms abundance of a brown amorphous body belonging to the class of those ill-defined bodies known as carameline, caramelane, &c. The liquid has a strong acid reaction and contains traces of lead or cadmium.

Observations on the Above Memoir.—M. Lodin.—The influence of saccharine solutions upon boiler-plating was discussed in a report presented July 2nd, 1878, to the Central Commission of Steam Engines, by M. Luuyt, and was published in the *Annales des Mines*, Series 7, vol. xiv. M. Lodin has also shown in a note communicated to the Academy of Sciences, July 26, 1880, that metallic iron reacting upon water in sealed tubes at temperatures a little exceeding 100°, gives rise to a liberation of hydrogen, accompanied by an attack of the iron. The presence of certain organic matters, such as starch and hematoxylin, intensifies the action.

Comparative Reactionary Aptitude of the Halogenous Derivatives of Sulphur.—W. Spring and A. Lecrenier.—The conclusions reached in this memoir are that for sulphur chlorides and bromides the quantity of free chlorine or bromine is so much the greater as the quantity of the substance employed differs more widely from S_2Cl_2 or S_2Br_2. If this fact is connected with the phenomena of dissociation made known by Michaelis, we are led to seek its origin in a true dissociation of these compounds. The affinity of chlorine for sulphur appears to be 9·43, and that of bromine 7·37 times greater than that of iodine; all other conditions being equal. The halogenous derivatives cannot in any manner be assimilated to alloys. They are not the result of the dissolution of a free portion of their elements in another combined portion, but their composition varies according to the laws of dissociation.

Direct Chlorination of Methyl-benzoyl.—H. Gautier.—In the action of chlorine upon methyl-benzoyl we obtain simultaneously the three chloro-substitution derivatives in the methyl group. But this process enables us to obtain only the mono-chloro product in a state of purity. The action of the chlorine must not be too prolonged, since this product is very soluble in the mixture formed by the bi- and tri-chloro derivatives.

On Effluviography.—D. Tommasi.—The substance of this brief communication has already been extracted from the *Comptes Rendus* (see Chemical News, vol. liii., pp. 179, 191).

MISCELLANEOUS.

A Reaction of Atropine and its Kindred Alkaloids.—A reaction observed by Gerrard was described in a former volume of *Zeitschrift*. Schweissinger has subjected it to a renewed examination and finds Gerrard's observation fully confirmed. He has also treated a number of other alkaloids (which Gerrard had not examined) in the same manner, which produced a red precipitate with atropine, *i.e.*, he covered 0·5 to 1 m.g. of each with an alcoholic solution of mercuric chloride and applied a gentle heat. Arbutine, condurangine, and sparteine gave no precipitate; cocaine yielded a white precipitate, but only in very concentrated solutions. Scoparine gave a yellow precipitate. The behaviour of hyoscyamine and homatropine is particularly interesting. If 1 m.g. of the former is covered with 2 c.c. of the 5 per cent alcoholic solution of mercuric chloride no precipitate appears, but if only two drops of the solution are used the precipitate comes up on gently warming, just as with atropine, and does not disappear on the addition of more of the mercuric solution. Homatropine, which with sulphuric acid and sodium nitrite behaves exactly like atropine, yields with alcoholic mercuric chloride no precipitate at all, is produced if the solution is dilute, but in a concentrated solution a white precipitate, which disappears on the addition of a further quantity of mercuric chloride; no red precipitate appears. The reaction is suitable for quantitative determinations; it applies only to the alkaloid itself and not to its salts. The caution is given that inorganic basic bodies, such as calcium and magnesium hydroxides, produce the very same precipitates.—*Zeitschr. f. Anal. Chem.*, xxv., Part 3.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Silver Plating.—Will some correspondent be kind enough to give me through your valuable paper a reliable "receipt" of a solution (silver) for electro-plating. I have made up several from text-books, but have not as yet got one to work satisfactorily. Two Smee's batteries should work it, should they not?—G. T. Craven.

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JOHN MERCER, F.R.S., F.C.S.,
&c.,
The Self-Taught Chemical Philosopher;
Including numerous Recipes used at the Oakenshaw Calico Print-Works.
BY
EDWARD A. PARNELL, F.C.S.,
Author of "Applied Chemistry," &c.
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Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S, Ardwick Chemical Works, Manchester.

THE CHEMICAL NEWS.

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NOTE ON THE USE OF SOAP SOLUTION.

By GEO. E. R. ELLIS, F.C.S.

IN working out the hardness of a water some analysts are wont to proceed thus: They make two determinations, in the first the soap solution is run in boldly, 5 c.c. or so at a time, and the hardness is approximately ascertained, while in the second the soap solution is run in at once *almost* up to the point of saturation, and is then carefully adjusted drop by drop.

In order to test the correctness of this mode of procedure the hardness of waters containing various salts in solution was determined under different conditions of treatment. Thus:

(1.) The soap solution was added slowly (1 c.c. or less at a time) and the sample was shaken for 10 seconds after each addition. (Call the number thus obtained A.)

(2.) The soap solution was added in bulk (almost up to the point of saturation, A), the mixture was shaken for 10 seconds, and the soap solution was then added drop by drop, until a permanent lather was obtained. (B.)

(3.) Experiment 2 was repeated, but the sample was allowed to stand for five minutes after the first shaking. (C.)

(4.) Experiment 3 was repeated, but the sample was allowed to stand for 15 minutes after the first shaking. (D.)

(5.) The soap solution was added almost up to the point of saturation (as in 2), the mixture was then shaken vigorously for 10 minutes, and the final point of the reaction then obtained by adding the soap solution drop by drop. (E.)

A large number of experiments were performed, but the data given in the following Table will be sufficient to show that the mode of procedure which some chemists employ is not calculated to give accurate results.

A glance at the Table will show that the numbers obtained under the head A are always less than those under C, and still less than those under B. Also we see that the more thoroughly the soap solution is made to mingle with the water the more nearly does the reading obtained approach to that given under A.

When we consider, too, that everything was done to make the experiments as strictly comparable as possible, and that the shaking in every case was continued for the same time and as nearly as possible in the same manner and degree, these numbers seem to indicate (1) that the mechanical act of shaking is more effective in the case of water containing calcium salts than in those containing magnesium salts, and (2) that the harder the water, within certain limits, the greater seems to be the percentage reduction in the quantity of soap solution required when the sample of water is vigorously shaken.

In the face of these results, therefore, in determining the hardness of a water, the soap solution should be added in *small* quantities (1 c.c. or less) at a time, and the mixture be well shaken after each addition.

I am aware that similar advice has been given by other chemists, but I have not been able to meet with the account of any experiments which bear out the value of the precept.

10, Colville Road, Bayswater, W.

No. of c.c. of Soap Solution required to produce a Permanent Lather under Different Conditions of Treatment of the Sample of Water.

Sample.	A.	B.	C.	(B−A).	(B−C).	Percentage reduction on shaking for 10 minutes.
I. Containing Mg and Ca salts, the latter in larger quantity	11·8	13·05	—	1·25	—	
II. Containing Mg and Ca salts, the latter in larger quantity	10·9	12·15	—	1·25	—	
III. Ditto, but in different proportions	11·47	12·73	12·53 D	1·26	0·2 (B−D)	
IV. Ditto „ „ „	12·75	14·15	13·84 E	1·4	0·31 (B−E)	
V. Ditto „ „ „	12·7	14·1	13·4	1·4	0·7	50
VI. Containing Mg salts only	13·18	14·74	—	1·56	—	
VII. Ditto	13·5	15·0	14·1	1·5	0·9	60
VIII. Ditto	11·64	13·0	12·37	1·36	0·63	46·3
IX. Ditto	10·05	11·36	10·73	1·31	0·63	48·1
X. Ditto	14·2	16·6	15·14	2·4	1·46	60
XI. Containing $CaCl_2$ in solution	10·44	11·47	10·82	1·03	0·65	63
XII. Containing $CaCl_2$ in solution	10·58	11·7	10·97	1·12	0·73	65

(1 c.c. of the solution = 1 grain of $CaCO_3$ per gallon).

THE SEPARATION OF ARSENIC, ANTIMONY, AND TIN.

By AD. CARNOT.

THE reactions of the alkaline hyposulphites in presence of various acids, upon which the author has founded the separation of a number of metals, may also serve for the separation of tin.

If, into a hydrochloric solution of arsenious or arsenic acid, heated to about 100°, we pour a solution of hyposulphite, there appears at first a white turbidity, due to precipitated sulphur, and then a yellow colouration produced by arsenic sulphide. The same phenomenon occurs in a solution acidified with oxalic acid. But the precipitation is always incomplete on account of the liberation of a certain quantity of sulphurous acid, which tends to bring back the sulphide to the state of arsenious acid. If we beforehand add to the liquid a solution of sulphurous acid, or of an alkaline disulphite, there is no longer formed a yellow precipitate, the sulphur deposited being quite exempt from arsenic. Under the same circumstances the precipitation of antimony oxysulphide is retarded, but still takes place completely. We have thus an easy means of separating arsenic and antimony. To the hydrochloric solution of the two substances it is sufficient to add ammonium oxalate (or, in the absence of tin, ammonium tartrate) and water; then hyposulphite in a quantity proportionate to the antimony; and, lastly, a little sulphurous acid or alkaline bisulphite, and raise to a boil. When the liquid becomes clear, and when an addi-

tion of hyposulphite or of hydrochloric acid no longer produces a white milkiness, it is filtered. We have then, on the one hand, the red precipitate of oxysulphide, in which the determination of the antimony is completed, and, on the other, a solution of arsenious acid, in which the arsenic is easily estimated. For this purpose there is added a large excess of hydrochloric acid; the liquid is heated until the sulphurous acid is expelled, and there is introduced a current of sulphuretted hydrogen, which determines the complete precipitation of arsenic sulphide. The arsenic is re-dissolved by peroxidising it with *aqua regia* or sodium hypobromite, and the determination is completed by one of the known methods. This method of separating arsenic and antimony finds numerous applications in the analysis of ores, and of other minerals in which these two substances are both present.

It is very rare, on the contrary, to find tin along with antimony in natural products, but the two metals are often associated in industrial alloys. We find there also sometimes arsenic, but in small quantities only, and generally in consequence of an impurity in the constituent metals. If all three are found together, the arsenic being in small quantity only, then after having dissolved in an *aqua-regia* (in which the hydrochloric acid is in excess) either the alloy itself or the mixed sulphides, previously separated from other metals by means of ammonium hydrosulphate, we separate first the antimony, as described above in the state of oxysulphide, taking care to prevent the precipitation of the tin and arsenic by means of oxalic and sulphurous acids. The liquid is then raised again to a boil, with a decided excess of hydrochloric acid, and into the almost boiling liquid there is passed a current of sulphuretted hydrogen. The quantity of arsenic being supposed to be small, its complete precipitation is effected if the gas is passed for a few moments. The liquid is kept hot as long as an odour of sulphuretted hydrogen is perceptible, and the formation of tin sulphide is prevented with almost absolute certainty. Nevertheless, for security's sake, the deposit which is slowly formed at the bottom of the flask is treated with a little hydrochloric acid, so as to re-dissolve any tin which it may contain. The residue is collected on a small filter, washed, and dissolved while still moist, in a few c.c. of hot *aqua regia*. The arsenic acid is then estimated as an ammonium-magnesium double salt, or by means of the Marsh apparatus.

The tin remaining alone in solution may pe precipitated as sulphide and determined by the ordinary methods.—*Comptes Rendus*, ciii., p. 343.

SPECTRUM OF THE NEGATIVE POLE OF NITROGEN: GENERAL LAW OF THE DISTRIBUTION OF RAYS IN THE BAND-SPECTRA.

By H. DESLANDRES.

The first portion of this memoir is specially reserved for the spectrum of the negative pole of nitrogen. The other part is devoted to a law of the distribution of rays which appears distinctly in the bands of the negative pole, but which appears general and common to all band-spectra.

The spectrum of the negative pole of nitrogen is, according to Angström, the only spectrum of any known body found in the Aurora Borealis. But this relation has been denied, as it rests only on the approximations of the wave-lengths.

The author proposes to compare directly by photography the two spectra placed in juxtaposition in the field of the spectroscope, and in the first place he has studied only one of them, the spectrum of the negative pole.

This spectrum appears especially strong in the negative part of the nitrogen tubes at ordinary pressures, and in the entire spark at very low pressures. In the luminous region, the only one studied hitherto, it is accompanied by faint traces of positive bands; but in the ultra-violet region it is only prolonged by a small number of bands, and is in a manner drowned among the strong and numerous positive bands.

General Law of the Distribution of the Rays.

The rays of the band λ 391 are distributed according to the following simple law: the intervals from one ray to the following, calculated in numbers of vibrations or the inverse numbers of the wave-lengths, are approximately in arithmetical progression. We may, in fact, form an arithmetical progression such that the difference between any interval of the band whatever and the corresponding term of the progression may be inferior to the ratio.

An analogous relation has been already pointed out by Piazzi Smyth and Herschel among sixteen rays of the green band of carbon monoxide, but it has been presented by them as an isolated fact. But this simple law appears general, and the author has verified it, almost in the same manner, with some secondary deviations for all the bands which he has been able to resolve into fine rays. The structure is in general much less simple, for most frequently the bands are formed not by a single series, but by several arithmetical series, equal, superimposed, and entangled one with another. The number of series is the same for the bands of the same origin. The author enumerates here the bands which he has studied from this point of view.

The other bands of the negative pole; the bands of the second positive group of nitrogen, which present each three equidistant arithmetical series; the bands of the third group from the positive pole of nitrogen (from λ 300 to λ 200), with three or four arithmetical series; the bands of cyanogen, with at least one series; the telluric bands A B α, which present each at least one series; the emission bands of watery vapour, which present at least four arithmetical series arranged in groups of two, each such group having the aspect of the bands A B α; one band of the combustion of coal-gas, near H, which appears lined with a similar but weaker band. It differs from the foregoing by the following features:—The ratio is greater, and the rays nearest to each other are not the most intense. This last peculiarity is shown still more distinctly in the violet band of the hydrocarbons.

In short, if we consider the great number and the different origins of the bands enumerated, this law appears general, and it is verified for the totality of the rays of one and the same band, in spite of certain irregularities or perturbations manifested by an oscillation of the series of intervals around the corresponding arithmetical series. In general a variation in the intensity of the rays appears accompanied by a variation of the intervals with regard to the progression.

In future, therefore, a band may be defined by the number and the dispersion of its component rays, by the position and the number of a ray of one series, and by the ratio of the progression. The number of series and the ratio are especially characteristic elements.

But the law enounced leads to the following consequence:—If we give to a ray of the series the number 1, and the numbers 2, 3 . . . n to the following rays, the interval between the ray n and the ray 1 is approximately represented by the binomial—

$$\frac{r}{2}(n-1)^2+s\,(n-1),$$

r being the ratio of the progression. Moreover we may select another origin and give another number to the ray which is at first the ray 1, so as to render the coefficient small, and at most equal to $\frac{r}{2}$. The intervals between the origin and the successive rays are then almost proportional to the squares of whole numbers. The foregoing results will be developed in a more extensive memoir.—*Comptes Rendus*, ciii., p. 375.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 89.)

X. *Relation between Silver and Chloride of Potassium*, γ 14—26.

Chloride of Potassium.	Equivalent in Silver. Saline Limit.	Equivalent in Silver. Silver Limit.	Ag : KCl = 100. Saline Limit.	Ag : KCl = 100. Silver Limit.	Ag : KCl = 100. Average.
7·08551	10·24160	10·2606	69·18362	69·05551	69·11956
7·07006	10·21920	10·23820	69·18408	69·05570	69·11989
8·14170	11·77880		Second method		69·12165*
10·01188	14·48410				69·12324

Chlorides of Potassium produced.	Silica for 100,000.	Silica for 69,120.	Rough Relationship (see below).	Corrected Relationship Ag : KCl = 100.
Chloroplatinate of Potash, 2nd Third, β 237	2 to 2½	1·4 to 1·75	69·11956	69·11799 *m*
	2 to 2½	Average	69·11989	69·11832
	2 to 2½	1·57	69·12165	69·12008 M
Chlorate of Potash, β 233..	5	3·5	69·12324	69·11974

Average 69·11903
Log. = 1·8395976

The estimations of 1860 gave, as the deduction made for silica, 69·1000.

XI. *Relation between Silver and Chloride of Sodium*, γ 19—28.

Chloride of Sodium.	Equivalent in Silver. Saline Limit.	Equivalent in Silver. Silver Limit.	Ag : NaCl = 100. Saline Limit.	Ag : NaCl = 100. Silver Limit.	Ag : NaCl = 100. Average.
6·07976	11·20817	11·22367	54·2440	54·16909	54·20654
5·73147	10·56710	10·57960	54·23881	54·17474	54·20677
11·33407	20·90819		Second method		54·20875
6·09238	11·23946				54·20527

Chlorides of Sodium produced.	Silica for 100,000.	Silica for 54,206.	Rough Relationship.	Corrected Relationship. Ag : NaCl = 100.
Chloroplatinate of Sodium, 1st Third, β 247	3·5	1·90	54·20654	54·20464
	3·5	1·90	54·20677	54·20487
Carbonate, β 244	5	2·71	54·20875	54·20604 M
Chloroplatinate, Last Third	4·5	2·44	54·20527	54·20283 *m*

Average 54·20460
Log. = 1·7340361

The estimations of 1860 and 1865 (α 280; β 286) gave, as the deduction made for silica, 54·204.

XII. *Relation between Silver and Chloride of Ammonium*, γ 20—30.

Chloride of Ammonium.	Equivalent in Silver. Saline Limit.	Equivalent in Silver. Silver Limit.	Ag : NH_4Cl = 100. Saline Limit.	Ag : NH_4Cl = 100. Silver Limit.	Ag : NH_4Cl = 100. Average.
5·56114	11·20298	11·22098	49·63983	49·56020	49·60001
5·57015	11·22115	11·23915	49·63974	49·56024	49·59999
5·42614	10·93999				49·59914
5·60658	11·30335 or 11·30349		Second method.. ..		49·60106* M or 49·60043
6·04850	12·19487				49·59872* *m*

Average 49·59978 (66)
Log. = 1·6954798 (87)

The chloride in the last estimation was prepared by Deville.
The estimations of 1860 (α 289) gave 49·5944; those of 1865 (β 57), 49·5968.

XIII. *Relation between Silver and Bromide of Potassium*, β 303.

No. of Experiment.	Bromide of Potassium.	Equivalent in Silver.	Ag : KBr = 100.
4	10·3519	9·3816	110·3426
5	14·8803	13·4850 ?	110·3470* M
6	25·11427	22·7612*	110·3381
8	15·0454	13·6360	110·3359
9	21·6969	19·6629	110·3444
10	9·20526	8·34305	110·3345*
11	20·1233*	18·23665	110·3454*
13	11·0613	10·0253	110·3339 *m*
14	16·3032	14·77585	110·3368*

Average 110·3398*

The total number of experiments was fourteen; but Nos. 1, 2, 3, 7, and 12 might be considered as affected by errors. However, M. Stas showed little satisfaction at this series of experiments. Of all the samples of bromide of potassium that of No. 9 is the only one whose contents of silica has been estimated. This bromide gave a chloride with 8·5-100,000ths to 9-100,000ths of silica; which represents from 5·7 to 6·2 for 110,000 of bromide of potassium. The relation is therefore brought from 110·3444 to 110·3385, the figure which I have adopted in my calculations. M. Stas has collected and weighed the bromide of silver produced by this experiment, No. 9; the result being 21·7301

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.

of bromide of potassium and 19·6929 of silver; gave 34·2817 of bromide of silver, from which we get—

Ag : AgBr = 100 : 174·0815,

which is identical with the mean of Table V., and also—

KBr : AgBr = 100 : 157·7614*,

which combined with the relation of Table V. leads to—

Ag : KBr = 100 : 110·3445,

which is identical with the figure shown above.

In 1882 (γ 37) M. Stas stated that he had not succeeded in procuring the hydrate or carbonate of potassium in a state of purity, and that it was, therefore, impossible for him to fix this relationship more definitely.

XIV. *Relation between Silver and Bromide of Sodium*, γ 46.

Bromide of Sodium.	Equivalent in Silver.	Ag : NaBr=100.
10·77950	11·29428	95·44211
14·85167	15·56152	95·43843*m
13·97650	14·64387	95·44265 M
10·04296	10·52288	95·43927

Average 95·44062*

The bromide used was obtained by saturating pure monosodic carbonate with the aid of hydrobromic acid. The chloride of sodium obtained from the same carbonate left, when volatilised, 5-100,000 of silica. Admitting that the retention of silica is proportional to the sodium contained in the two compounds, the bromide of sodium used in the experiment should contain 2·85 of silica per 100,000, or 2·72 per 95,441, which brings the relation to—

.. 95·4379

Log. = 1·9797208

THE ACTION OF HYDROFLUORIC ACID ON SILICA AND SILICATES.

Preliminary Notice.

By J. B. MACKINTOSH.

It has been known for some time that some silicates, such as zircon, are not affected by hydrofluoric acid, and this fact has been utilised in order to purify crude zircons for analysis,* and to separate the various constituent minerals in rocks.† Messrs. Fouqué and Lévy state—"L'acide fluorhydrique attaque d'abord les matières amorphes, puis les feldspaths, puis le quartz cristallisé, et enfin les silicates ferrugineux et le fer oxydulé. . . . Si, par exemple, on traite une ponce, mélange de matière amorphe et de minéraux cristallins, on attaque successivement la matière amorphe, les feldspaths, puis l'olivine, le fer oxydulé, l'amphibole, le pyroxène." My attention was first directed to this subject by finding that garnet was not affected in the slightest degree by the concentrated acid, and since then I have tried a larger number of silicates, about half of which are also unattacked. My results, however, differ somewhat from those of Fouqué and Lévy as quoted above. Generally speaking, those minerals which have a more condensed molecule are less easily attacked than those with a less condensed molecule, which fact is highly in favour of the "Natural System in Mineralogy" proposed by Dr. T. Sterry Hunt. When Dr. Hunt, to whom I am indebted for suggestions and information, first learned that I was experimenting in this direction, he predicted correctly the action on some species, and suggested that I should make my experiments quantitative.

The results of these quantitative experiments are of very great interest. I will, however, only give here the difference between the two forms of silica, quartz, and opal. When 1 grm. of each, reduced to a uniform average size of $\frac{1}{100}$ cubic millimetre, was treated with an excess of dilute hydrofluoric acid (9 per cent) in the cold for one hour, the quartz lost only 1·56 per cent, while the opal had lost 77·28 per cent. With crystals of quartz and pieces of opal of corresponding size, the difference is still more strongly marked. Even when treated for one hour in concentrated (54 per cent) acid, quartz crystals suffered a diminution of weight of about 0·04 per cent and 0·24 per cent, while in the dilute acid for the same length of time opal lost 28·5 per cent. The differences in the amounts dissolved off different quartz crystals seems to have much more than merely chemical significance, and to be connected with those molecular dissimilarities which cause the differences between right- and left-handed quartz, the occurrence of plagihedral faces, and of those rhombohedral faces which differ in angle from the primitive form. —*School of Mines Quarterly*, vol. vii., p. 384.

* Linnemann, Chemical News, November 6th, 1885.

† "Mineralogie Micrographique," F. Fouqué et Michel Lévy. Paris, 1879, p. 116.

ON THE CHEMICAL COMPOSITION OF HERDERITE AND BERYL,

With Note on the Precipitation of Aluminum and Separation of Beryllium and Aluminum.*

By S. L. PENFIELD and D. N. HARPER.

(Concluded from p. 92).

4. *On the Separation of Aluminum and Beryllium.*

Various experiments convinced us that the following methods are not satisfactory: precipitation of the alumina as basic acetate, some beryllium being also precipitated; precipitation of the alumina with barium carbonate; solution of the beryllium in a boiling solution of ammonium chloride; by long boiling of a solution of ammonium chloride the solution becomes slightly acid, and according to our own experience some alumina is dissolved, while Genth† found that the beryllium was not completely dissolved. Solution of the beryllium in and precipitation of the alumina with ammonium carbonate gives unreliable results, and the method, when carried out as described by one of us in making a series of beryl analyses‡ gave too low results for beryllium.

We have made a large number of separations by dissolving the mixed chlorides in the least possible excess of caustic soda, diluting the solution largely, and precipitating the beryllium by boiling. This method has recently been proposed by Genth§ as the most reliable of the known methods, and Baker‖ used it successfully in his analysis of beryl. Before using the method in our own work we made a series of experiments to determine its accuracy and to find out the best conditions for making the separation. A standard solution of beryllium chloride was made from purified K_2BeF_4 containing 0·1107 grm. BeO in every 50 c.c. Our standard solution of aluminum chloride contained 0·1002 grm. Al_2O_3 in every 50 c.c. Neither of the solutions contained any alkali and not more than traces of sulphuric acid.

The method was as follows:—50 c.c. of each solution were measured into a platinum dish and evaporated to dryness, the chlorides were dissolved in the least possible quantity of water, and a rather strong solution of pure soda, made from metallic sodium, was cautiously added until the precipitate which at first formed was completely dissolved. The contents of the dish were then rinsed with cold water into a beaker containing about 800 c.c. of boiling water and the contents of the beaker boiled for

* From the *American Journal of Science*, vol. xxxii., p. 197.

† *Proc. Amer. Phil. Society*, xxi., 694, 1884.

‡ *Loc. cit.*

§ *Loc. cit.*

‖ *Amer. Chem. Journal*, vii., 175.

one hour, replacing from time to time the water which evaporated. The beryllium separates out as a granular precipitate which is easy to filter and wash. After acidifying and concentrating the filtrate the alumina was precipitated with ammonia. Our experience has taught us that the best results are obtained by dissolving the dried chlorides in the least possible quantity of water and using as little soda as possible for dissolving the aluminum and beryllium.

Below we have given in tabulated form the results of our experiments.

	Weight of Al_2O_3.	Weight of BeO.
	0·1041	0·1093
	0·1057	0·1080
		0·1096
	0·1045	0·1099
		0·1107
	0·1032	0·1093
	0·1037	0·1093
	0·1031	0·1083
Average	0·1040	0·1093
Standard	0·1002	0·1107

The precipitates were in all cases ignited for a long time to full redness over a ring burner. It will be seen that the BeO is quite constant and the average only a little below the standard. The Al_2O_3 is in all cases too high. If the quantity of mixed beryllium and aluminum oxides be determined in any compound, and then the BeO separated according to the above method and the Al_2O_3 determined by difference, the results will be very nearly correct. The determinations of Al_2O_3 and BeO in beryl given earlier in this article was made in this way.

To account for the excess of Al_2O_3 we thought that perhaps appreciable quantities of silica were dissolved from the glass by boiling the alkaline solutions of the mixed oxides for one hour. We therefore in every case dissolved the oxides in hydrochloric acid and deducted from their weight a slight quantity of insoluble matter amounting to about 0·0010 grm. in the Al_2O_3 and 0·0004 grm. in the BeO. The excess of Al_2O_3 must, therefore, have come from some other cause than silica dissolved from the glass. The alkaline solutions are so dilute that the glass is very little acted on, and determinations made in a platinum dish convinced us that the separation can be made just as well in beakers. We have concluded that the beryllium is not completely precipitated from a solution in soda by boiling and that it is not possible to wash out all of the soda from the precipitate. The following experiments on the determination of BeO in beryl will show this. The first column gives the weight of BeO obtained by boiling the soda solution, the second the same oxide dissolved in hydrochloric acid, re-precipitated with ammonia, and ignited.

0·1476	0·1440
0·1464	0·1422
0·1330	0·1300
0·4270	0·4162

The total BeO in these experiments weighed 0·4270 on first precipitation, 0·4162 on second, a loss of 0·0108. Calculating by proportion the loss which would result from 0·1107 grm. BeO, the quantity used in our first experiments, we find—

$$0{\cdot}4270 : 0{\cdot}1107 = 0{\cdot}0108 : x, \quad x = 0{\cdot}0027$$

that is, in the quantity of BeO which we used in making our experiments, the BeO was too heavy by about 0·0027 grm., representing probably some soda compound which could not be removed by washing. The excess in the Al_2O_3 is due to the BeO which was not precipitated by boiling. If we take the sum of the Al_2O_3 and BeO in the average of our determinations 0·2133 and deduct from it 0·0027, we have 0·2106 against 0·2109, the sum of Al_2O_3 and BeO in our standard. The following determinations made from our standard solutions, the boiling of the soda solutions being done in platinum, confirm us in this. First weight of BeO 0·1087, after solution and re-precipitation 0·1068, weight of Al_2O_3 0·1041. 0·1068+0·1041=0·2109, the weight of mixed oxides in our standard. We conclude, therefore, that the separation is not as perfect as our results would indicate. The error is, however, very constant, the amount of BeO which is not precipitated being almost exactly equal to the amount of soda which it seems impossible to remove from the precipitate by washing.

When phosphoric acid is present alumina may be separated from beryllium by boiling the solution of the mixed chlorides with barium hydroxide. The alumina goes readily into solution, while the precipitate containing the barium phosphate and beryllium is easy to filter and wash. After dissolving the precipitate and separating the barium with sulphuric acid, a beryllium phosphate can be precipitated with ammonia. After weighing this the P_2O_5 may be determined by means of ammonium molybdate and the BeO by difference, or the precipitate may be fused with sodium carbonate and the fusion soaked out with water, which gives almost a complete separation of phosphoric acid from beryllium. If phosphoric acid is also to be determined it must be borne in mind that very perceptible quantities of it will be found in the barium sulphate precipitate.

We have also observed that when Al_2O_3 is ignited over a ring burner till a constant weight is obtained, then over a blast lamp, there is a slight loss, amounting in the quantities which we have used in making the above experiments to about 0·0010 grm. What this loss represents we are not able to say. Usually in practical work this error can not be avoided, because it is necessary to dissolve the ignited Al_2O_3 to test for traces of SiO_2 or iron, and it is almost impossible to dissolve Al_2O_3 which has been strongly ignited over a blast lamp. The same is true for ignited BeO. After strong ignition over a ring burner there is still a loss of about 0·0013 in the quantities which we used, by igniting for five minutes over a blast lamp. This may be done, however, as the ignited BeO is readily soluble in hydrochloric acid.

In closing we wish to express our thanks to Messrs. Geo. J. Brush, L. Stadtmüller, and Geo. F. Kunz for the rare material which they kindly furnished for carrying out this investigation.

THE SANITARY VALUE OF THE CHEMICAL ANALYSIS OF POTABLE WATERS.*

BY WILLIS G. TUCKER, PH.D.

FOR the past six months or more the subject of our city water supply has received an unusual amount of attention from the citizens of Albany. Very naturally questions concerning the various methods of water analysis and their value have come under discussion, and it is possible that a brief description of those processes which are employed by chemists to-day and a discussion of their respective merits may be of interest at this time. It may be profitable also to inquire what are the questions which a chemical analysis can positively answer and incidentally to consider the probabilities of disease transmission by water used for drinking and the effect of natural oxidation by aëration in purifying those which are polluted by sewage matter.

The general appearance and physical properties of a water will naturally first attract attention when its quality is questioned. An ideally pure water will be clear and colourless, odourless and tasteless, but these qualities, however desirable in themselves, do not necessarily indicate freedom from pollution. Waters which have penetrated through the soil are generally bright and clear

* A Paper read before the Albany Institute.

from the filtration they have undergone, and may have neither odour nor taste and yet be very dirty waters chemically, while surface waters may show a decided colour and even turbidity, may have an earthy, vegetable, or peaty odour and taste, and yet be quite free from harmful constituents. *Pure* water does not exist in nature, all dissolved or suspended substances being impurities in water as such, though by no means necessarily harmful. The sensible properties of a water, therefore, unless it be so foul that there is no mistaking its pollution, afford little information as to its quality. Water may percolate through the soil for a mile under a mountain and be as clear as crystal and yet carry typhoid fever from a hamlet on one side to dwellers on the other, as in the celebrated and well authenticated case at Lausen, Switzerland.

The suspended matter contained in potable waters, and naturally most abundant in surface waters, usually consists chiefly of clayey matter, easily removed by filtration on a large or small scale or by mere subsidence. In some cases, however, as in the James river water which supplies Richmond, the suspended matter is so finely divided that its removal is well nigh impossible, but such matter may generally be disregarded as unimportant from a hygienic point of view. The dissolved constituents consist both of gaseous and solid substances. The former may be the atmospheric gases only, and aside from the indications which the quantities of nitrogen and oxygen and the ratio between them are thought by some to afford as to the amounts of organic matter which are undergoing oxidation their quantity is of little importance. Sulphuretted hydrogen and other noxious gases may indeed be present as the result of putrefactive changes or peculiar conditions, and the recognition of such constituents may become a matter of importance, not because they are in themselves capable of producing disease in the quantities which may be present in water, but because their existence throws light upon the chemical changes which are taking place.

The dissolved solid constituents of potable waters are both inorganic and organic, the latter either of animal or vegetable origin. Up to twenty years ago the ordinary method of quantitative determination was to evaporate a definite quantity of the water to dryness in a platinum dish, weigh the residue, calculate the percentage of total solids, and then determine the organic or volatile matter by the loss resulting from the ignition of the total solid residue, due correction being made for the loss of carbonic acid. A complete analysis was then usually made of the mineral constituents, but as the precise amounts of these are of little importance and as the method described for determining the organic matter afforded no clue to its nature and was too inexact to be of value even in ascertaining the amount with accuracy, it may be readily seen that the results thus obtained were of little or no sanitary value. In speaking of the exact determination of the mineral constituents as unimportant reference was had to the lime, magnesia, iron, and other salts usually occurring in all natural waters save rain water, and not to the chlorine, phosphoric acid, nitrates, and nitrites which are important, but which formerly received less attention than at present. For manufacturing purposes of course a soft water is generally to be preferred. Hard waters, however, act upon lead less than soft ones, while on the other hand they occasion a waste of soap and are not desirable for culinary purposes; but these are incidental questions, and it cannot be said to be proven that the amount of mineral matter in potable water exercises much influence upon its healthfulness. In most cases a mere determination of the hardness is quite sufficient, a water not too hard being generally preferred, though the total solids are likewise determined when a complete analysis is made.

Let us now briefly consider those inorganic constituents which are generally regarded as important from a hygienic standpoint.

1. *Chlorine.*—This occurs chiefly in combination with sodium. In waters not naturally brackish the determination of its amount is regarded as decidedly important. Chlorides occur in all human excreta and slop waters, and, therefore, in all sewage, and their presence in considerable quantity is a sign of probable contamination. The estimation is generally made volumetrically with a nitrate of silver solution. Over five parts in 100,000 were regarded by the Rivers Pollution Commission of Great Britain as in most cases due to sewage contamination.

2. *Phosphoric Acid.* — "Much nonsense," says Wanklyn, "has been talked about phosphates." This talk has had to do with the presence of phosphates in sewage and the evidence afforded by them of such contamination. The fact, however, is that in presence of carbonate of lime phosphates can only exist in exceedingly small traces in a clear water, but a qualitative test for their presence is usually made.

3. *Nitrites and Nitrates.*—These compounds are believed to result mainly from the oxidation of nitrogeneous organic matter, chiefly animal, and are considered by some chemists as indicating quite accurately the amount of such defilement. In themselves, of course, they are harmless, but if they aid us in determining the amount of pollution their quantity becomes a matter of importance. It is now pretty generally conceded that the conversion of nitrogenous organic matter into these forms takes place under the influence of micro-organisms and is a process of fermentation, the rapidity of which depends upon degree of dilution, temperature, and other conditions. Recent experiments, as, for instance, those of Warington at the Rothamsted laboratory reported in *Nature*, for October 30, 1884, seem to prove quite conclusively that such is the case, and if so, the old view that nitrification is a mere oxidation must be abandoned, and our ideas concerning the value of natural aëration, long considered by many chemists so important, must be greatly modified. Warington asserts that nitrification will not take place in an acid solution. Some base must be present with which the nitric acid formed may combine, and when this is exhausted the oxidation ceases. If this is true then a study of the amount of certain mineral constituents present in a water which may furnish bases to the nitric acid produced, becomes indirectly important in determining the rapidity and completeness with which sewage matter may be oxidised, and a study of this subject, yet practically undeveloped, bids fair to yield valuable results.

At the same time it is to be borne in mind, as Wanklyn and others have pointed out, that certain mineral strata yield nitrates to water containing no organic matter, and that processes of vegetation in rivers and lakes withdraw them from water. Also that nitrates once formed may be again reduced to ammonia compounds or even to free nitrogen. If so, then an undue importance has been attached to the determination of nitrogen in this form, by Frankland and others, who make use of the term "previous sewage contamination" to denote the amount of sewage which has been discharged into a water and undergone oxidation, estimating the same by determining the total combined inorganic nitrogen present, as ammonia, nitrates, and nitrites, and after deducting the amount of nitrogen present in these forms in rain water, calculating how much "average London sewage" would be required to account for it. It will therefore be seen that much difference of opinion exists as to the degree of importance to be attached to the presence of these compounds in water, and that the questions involved are exceedingly intricate and as yet very far from being settled. Various methods are employed in their determination, none of which are perfectly satisfactory.

We may now dismiss from further consideration the inorganic constituents of potable waters, and proceed to describe those methods of analysis developed during late years which have for their object the determination of the amount and so far as possible the nature of the organic constituents, so much more important than the inorganic, from a sanitary point of view. The following are the most important of these processes:—

1. *Permanganate Methods.*—In 1849 Forchammer pro-

posed the use of permanganate of potassium for the determination of the oxidisable matter in water. This salt imparts, even in very small quantities, a decided pink colour to water, and as it contains a large amount of oxygen which it readily gives up to reducing bodies, thereby losing its characteristic colour, its use affords a ready method for the determination of the amount of many such substances in a state of solution. As applied to the determination of organic matter, however, the results can have no absolute value, since different kinds of organic matter require for oxidation different amounts of oxygen, and moreover differ in the completeness with which they are oxidised and the length of time required. Much also depends upon the exact method in which the test is applied, and various inorganic compounds which may be present reduce the permanganate and become a source of error. Nevertheless this test has a certain value, and it was at one time even thought that the amounts of putrescible matter might be estimated by the amount of permanganate decolourised during the first few minutes, since such matter probably first undergoes oxidation. Frankland held this view, as did Angus Smith, but the former has of late entertained a different opinion. W. A. Miller, Kubel, Tidy, Letheby, Schultze, and others have proposed particular methods for the application of this test, that most in use at the present time being Tidy's modification, which consists in the addition of a definite amount of permanganate solution to a certain quantity of the water acidified with sulphuric acid. At the end of a certain length of time the amount of permanganate remaining is determined, and the amount of oxygen consumed is calculated and reported as "oxygen absorbed." Very generally, two determinations are made on different samples of the water, the permanganate being allowed to act for fifteen minutes in one case and for three or four hours in the other.

Tidy and his adherents attach great importance to the results thus obtained. Frankland admits that they are not without value, and finds that they corresponded in 418 out of 1686 cases quite closely with those obtained by his own very elaborate method presently to be described. Wanklyn condemns the method as misleading on account of want of delicacy, and the fact that albumen is not readily attacked by the standard solution of permanganate, while, as Frankland long ago pointed out, such bodies as starch and cane-sugar take up less than the one-hundredth part of the oxygen required for total oxidation. The majority of water analysts probably realise the imperfections of all permanganate methods, but consider their indications as not without a certain value. In this connection it may be remarked that Wanklyn has proposed and patented a method known as the "moist combustion process," in which an alkaline solution of permanganate is distilled with the water and the amount of permanganate consumed determined. It has not been received with much favour.

2. *Wanklyn and Chapman's Albumenoid-Ammonia Process.*—The ammonia method so well known and largely employed at the present time was brought forward by Wanklyn, Chapman, and Smith, in 1867. The modified process now in general use is described in the fifth edition of Wanklyn and Chapman's "Water Analysis." No method has ever found such general favour among analysts, a fact perhaps in part owing to the comparative ease with which the test is applied, the general nicety of the process, and the seeming accuracy—certainly delicacy of the method. Nevertheless it has been harshly criticised by many, and especially by Frankland and his followers.

In this test a definite quantity of water is boiled in a retort, some carbonate of sodium having been added if necessary to render the water alkaline, and the ammonia which existed as such in the water or has resulted from the decomposition of urea and like substances, passes over with the escaping steam, which is condensed and the amount determined with Nessler's solution and reported as "free ammonia." When this has all been given off an alkaline solution of permanganate of potassium is added, and the distillation continued. Certain kinds of organic matter containing nitrogen are thus decomposed, giving off a part or all of their nitrogen as ammonia, and since albumen is one of these, the ammonia so obtained is called "albumenoid-ammonia," and reported as such.

This process was the first to come into general use, which claimed to distinguish readily putrescible nitrogenous matter from those organic substances which are with greater difficulty converted into ammonia, and much importance was naturally attached to the results obtained in distinguishing pollution due to animal matter from that of vegetable origin, but as different amounts of ammonia are yielded by the same weights of different substances, and as the conversion of many such into ammonia is by no means complete, the results can have no absolute insignificance. On these and other grounds Frankland rejects this method utterly. Tidy, likewise, while admitting that the process might be used to discriminate between a water of excellent quality and one exceedingly bad, holds that when water of intermediate character is under examination, it "utterly and entirely fails." It is to be borne in mind, however, that both Frankland and Tidy are committed to methods of their own, which they advocate not without the exhibition of a partisan spirit, and their conclusions are, therefore, hardly entitled to the same weight as those of less prejudiced, though, perhaps, less distinguished, experts. The rank and file of water analysts have accepted this method as affording very valuable information, and in the elaborate "Preliminary Report on the Results of an Investigation made by direction of the National Board of Health, as to the Chemical Methods in Use for the Determination of Organic Matter in Potable Water," made by Professor Mallet, of the University of Virginia, in 1881, and printed in the report of the National Board of Health for 1882, the author, while he points out the defects of the process, finds "that it is admittedly simple and easily carried out;" that "the value of the results depends more upon watching the *progress* and *rate* of the evolution of the ammonia than upon determining the total amount:" and that "taking the results by this process as recorded, we find a great deal of similarity between the figures for albumenoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent such as prevent the one being taken as the accurate measure of the other."

3. *Frankland and Armstrong's Combustion Process.*—This is the third and last of the important processes now in use. It was brought forward by its originators in 1867, and first described in print in the *Journal of the Chemical Society* (London) for March, 1868, and is by far the most elaborate method of any in use. It was employed by the Rivers Pollution Commission of Great Britain in the examination of a large number of waters. The process consists in the evaporation of a stated quantity of the water which has been freed from all the carbon and nitrogen which existed in it in an inorganic form, excepting in ammonia, by treatment with a saturated solution of sulphurous acid, by which the nitrates and nitrites are reduced with the expulsion of their nitrogen, and the carbonates decomposed with liberation of their carbonic acid. Nitrogen in ammonia is fixed, and has to be deducted in the final computation. The residue obtained is then submitted to organic analysis, resulting in the conversion of the carbon into carbonic acid, and the liberation of the nitrogen as such. The mixture of gases is then subjected to volumetric gas-analysis, and the results finally reported as parts of "organic carbon" and "organic nitrogen" in 100,000 of water. The relative proportion of nitrogen to carbon is supposed to throw light upon the nature of the organic matter originally present, since in animal substances the ratio is higher than in vegetable. Frankland finds that the ratio of nitrogen to carbon is for upland surface waters, on an average,

1 to 10; for water from cultivated land, 1 to 6; for shallow wells, 1 to 4; for sewage, 1 to 2. It has been found, however, that the effect of oxidation upon peaty matter is to diminish the proportion of carbon, while during the oxidation of animal matter it is the nitrogen which diminishes most rapidly. Therefore, the proportions of nitrogen to carbon in vegetable and animal matter vary in opposite directions during oxidation, a fact which greatly adds to the difficulty of deciding as to the nature of the organic matter present.

This process is, in theory, the most scientific and accurate of any ever proposed, but it is exceedingly difficult, requiring costly and elaborate apparatus and especial skill on the part of the operator. Mallet says, "It is better adapted to regular use in the analysis of many samples of water in a large public laboratory, than to occasional use by a private individual in now and then examining a sample of water." For these reasons, chiefly, it has not come into general use, and in this country it has been employed by but very few chemists. Objections on the score of difficulty, however, should not be allowed to weigh against the process itself if it is of value, but on this point much difference of opinion exists. As might be supposed, Wanklyn and Tidy condemn it, and while most chemists admit that the principle is a good one, it is pretty generally believed that its indications are by no means as reliable as they are claimed to be by the originators of the process. Mallet, after summing up its errors and the objections to it, says:—"The combustion process, in its present form, cannot be considered as 'determining' the carbon and nitrogen of the organic matter of a water, in a sense to justify the claim of 'absolute' value for its results, which have been denied to those of all other methods. It is but a method of approximation involving sundry errors, and in part a balance of errors."

(To be continued.)

NOTICES OF BOOKS.

The Life and Labours of John Mercer, F.R.S., F.C.S., &c.,—the Self-taught Chemical Philosopher. By E. A. Parnell, F.C.S. (Author of "Applied Chemistry"). London: Longmans, Green, and Co.

We have here, at last, a memoir of a man of whom not only his native district, but the tinctorial chemistry of Britain, has every reason to be proud. Though reared amidst circumstances anything but favourable, and living at a time when manuals of chemistry were both scarce and imperfect, he mastered by his unaided exertions one of the most delicate and complicated departments of chemical art, and became a brilliant and successful inventor. Not only so: he gained a profound insight into the philosophy of chemistry, speculating acutely on such subjects as catalysis, the mutual relations of the atomic weights, the motive theory of heat and electricity, &c. Nay, the occurrence of mould in some shipments of printed calicoes led him not merely to devise a remedy, but to speculate on the part played in fermentation by "organised" bodies, or what we now call germs or microbia. Mr. Parnell remarks that if his environment and pursuits had been different he might have developed the microbe doctrine of disease which we have now learnt from Pasteur and Koch.

But we shall be mistaken if we suppose that his attention was confined to the laboratory. He was an energetic man of business, who had he been swayed by greed would have acquired great wealth. He was active in promoting the welfare, physical, sanitary, moral, and religious, of his neighbours and dependents, and was, in short, in every way a power for good in his district.

John Mercer, at the age of eighteen, was bound apprentice to the colour-shop of Messrs. Fort, of the Oakenshaw Print-Works, the same establishment in which he afterwards became a partner, and where he made his world-famed inventions. Here he met with an unforeseen, though not uncommon, difficulty. A young man who shows industry and ability, especially if he attracts the favourable notice of his employer, is liable to the jealous dislike of foremen, managers, &c., who use every artifice to injure his character, and are too often successful, unless the employer is one of those exceptional characters who see with their own eyes.

In consequence of the notorious "Berlin decree" of the first Napoleon, Messrs. Fort were compelled to reduce their establishment, and, as they offered to cancel the indentures of all apprentices who were willing, Mercer took the opportunity and left their service, and returned to his original business of a hand-loom weaver, to which he added that of dyeing. He succeeded, we are told, in making profitable use of the imperfectly spent materials of the print-works, which he purchased at a low price. In the spring of 1814 occurred a little incident which had great influence on his industrial career. At an old book-stall in Blackburn he met with a copy of Parkinson's "Chemical Pocket-Book, or Memoranda Chemica." This work, he says, introduced him into a new world, and gave a definite direction to his experiments. In 1817 he succeeded in applying the orange antimony sulphide in calico-printing, an invention which brought him back to Messrs. Fort's works as the head of the colour-shop. Here he brought out a stream of successive inventions, several of which led to very popular styles. He detected the constitution of indigo-whites, and invented the application of chromate of potash in producing yellow and orange designs on variously coloured grounds, and of discharging indigo. His next step was the production of manganese bronze, with which he produced a number of telling styles. His method of extracting cochineal and lac by means of a neutral alkaline oxalate was another important advance, especially as cochineal was then very expensive.

In the colour-shop he adjusted the strengths of his solutions in a simple relation to the equivalents of the substances. In his receipts he divided the imperial gallon into 16 gills, and the gill into 16 spoons, each spoon being again divided into 16 parts. Mr. Parnell remarks that these gills were not the common gill; but he forgets that in Lancashire the gill has, from time immemorial, represented 10 fluid ounces, and not 5 as in the South of England.

About 1827 he devised a volumetric process for testing bleaching-powder and bichromate of potash. Next followed a new method of fixing Prussian blue, a new oxidising agent for catechu, the use of sulpho-cyanide of potassium as a discharge, and a new application of red prussiate as an oxidising agent. Two of his inventions "outside the factory" here deserve notice,—a process for making artificial magnetic iron oxide, and a method of bleaching palm oil. We find him next introducing the arseniates and phosphates as substitutes for cow-dung, making important improvements in "preparing" delaines, and employing aluminous lakes, dissolved in neutral ammonium oxalate, in steam styles. Then followed his assistant mordant liquor, his dry process for making stannate of soda. His studies on Turkey-red dyeing, on madder and garancine, on red and black liquors, on ferro-cyanides and nitro-prussides, and on "the properties of alumina" are significant. It was his nature to trace to its cause, if possible, every phenomenon detected in the course of ordinary work, and to arrive at fresh results from the conclusions thus reached. To such a mind business and research ran hand in hand.

In 1848 the Oakenshaw firm was dissolved, and Mercer retired from business. His aim had always been the production of first-class work, and the reputation of the firm had been built upon such goods. But the modern competition springing up in all industries "led to the large propuction of inferior goods at a cheaper rate,"—kind of work out of harmony with his tastes. His mind

striking discovery, though one which has not met with due practical appreciation, is the process of "mercering" cotton. It has been said in depreciation of this invention that the same effects can be produced more cheaply in the loom. This is simply nonsense; nothing done by or in the loom can increase the receptivity of cotton for colouring-matters. Mr. Parnell gives the true reason, namely, that "competition renders it expedient, in the judgment of the manufacturer, to sacrifice durability and intrinsic excellence" to shams and low prices. In a word mercerising did not agree with the "cheap and nasty" principle.

John Mercer ended his active and honourable career in his seventy-sixth year, 1866, after two years of severe suffering, regretted by all who had come within the sphere of his influence.

An Appendix contains a number of his laboratory notes and colour-shop receipts. Many of these have passed into general use, the more so as Mercer freely imparted to others knowledge which many would have kept a close secret. Others have lost their chief practical value now so many of the wares with which he worked have been superseded by the coal-tar colours. But we are of opinion that there is much here which will prove suggestive, whilst the whole of Mercer's career must prove a noble and encouraging example to the young industrialist.

Mr. Parnell deserves well of the chemical and technical world for this ably-compiled volume.

Barbados. Results obtained on the Experimental Field at Dodd's Reformatory. 1886.

We have here a report presented by J. B. Harrison, Professor of Chemistry and Agricultural Science to the Colony, and J. R. Bovell, Superintendent of the Reformatory. These gentlemen have carried out a series of experiments on the growth of the sugar-cane, and have obtained some important results. The soil upon which they operated was decidedly poor, containing—nitrogen, 0·1018; phosphoric anhydride, 0·079; and potash, 0·106. The manure supplied contained nitrogen = ammonia, 56 lbs. per acre; soluble phosphate, 106·06 lbs.; reverted phosphate, 2·91 lbs.; and insoluble phosphate, 3·58 lbs. Potash was given at the rate of 34·83 lbs. per acre, the original intention being to use 56 lbs. per acre, but the potash salts purchased for this purpose were found to contain only 49·34 per cent of "muriate" instead of 80 per cent as represented.

The yield of canes was much greater when sulphate of ammonia was used as the source of nitrogen than in the case of nitrate of soda. The addition of potash salts along with the nitrogenous matters increased the weight of canes per acre by 4000 lbs. in case of sulphate of ammonia, and by 3000 lbs. in case of nitrate of soda. The results lead to the suspicion that potash exerts a special manurial action on the sugar-cane. It is to be noted that the amount of soluble ash (chiefly potash salts) is not appreciably increased by considerable doses of potash salts.

The influence of drought upon the composition of the sugar-cane is unfavourable. In two comparative cases it was found that the crystallisable sugar was reduced by drought 4 per cent, whilst the glucose was doubled and the woody fibre was increased from 12·50 to 14·72 per cent. By judicious manuring the yield of sugar was increased 11·4 per cent.

A number of experiments were made with various artificial cane-manures supplied by different merchants. This was "intended, if possible, to arouse some interest in these experiments among the planters,"—an object in which it entirely failed.

An unsatisfactory result of these investigations is that the cane does not contain the proportion of sugar in its juices with which it has been credited by different writers. The proportion of total sugars left in the megass is very much less than usually assumed.

"It has been common among chemists to calculate the proportion of sugar in the whole cane from the amount present in the juice extracted, assuming that that left in the megass possessed the same composition." Hence the total sugar in average canes will not exceed 16·5 per cent. Hence the extra amount of juice extracted by increased pressure is poorer in sugar, and contains at the same time more impurities than the juice expressed by lower pressures.

The Gas and Water Companies' Directory, 1886. Edited by Charles W. Hastings. London: Scientific Publishing Company (Limited).

This Directory, which has now reached its tenth yearly issue, shows the date of formation of each company, the date of its special acts, if any, the share capital, dividends, debts; the names of the chairman, manager, and secretary; the lessee, owner, or corporation; and, lastly, the population of the town, its distance from London, and the railways by which it is reached. There is no scientific or technical information, but the Directory will be exceedingly useful to all persons who have business with the companies in question.

Gas-Works Statistics, 1886. Edited by C. W. Hastings London: The Scientific Publishing Company, Limited

This compilation shows in parallel columns opposite the name of each town the date when the returns given were made—one of which, we perceive, is as far back as June 30th, 1882—the tons of coal used, the annual make and sale of gas, the illuminating power, the price per cubic feet, the number of consumers, the price paid for public lamps, the average price obtained for coke, and the tons of sulphate of ammonia made. Under this last head the returns are few. We presume the fall in the value of all the by-products of the gas manufacture checks the extension of operations in this direction. The illuminating power has a very wide range, from 12 to 30 candles, the latter magnificent result being reached at Berwick-on-Tweed, at a figure which, though high, is decidedly below the price charged for a much inferior gas in many other places. The highest price per thousand cubic feet is 10s., and the lowest are at Hull 1s. 9d., and at Leeds 1s. 10d., with a discount of 2½ per cent. The prices stand in no definite relation to the illuminating power, nor yet, as far as we can perceive, to the prices of coal in the neighbourhoods.

A comparison of the respective quantities of gas made and sold in certain towns leads to some very curious results. Thus, in several cases, these two quantities are exactly equal, proving that leakage from the mains and other forms of waste have been reduced to zero. This speaks of careful management. In other towns, on the contrary, the sales fall short of the make by a serious proportion (such as 1-6th, or even 1-5th of the entire yearly production). This is to be regretted, as proving the existence certainly of waste, and possibly of a nuisance and a source of danger. But in one instance we note a still more interesting result. At Nelson-in-Marsden the annual make of gas is reported as 50,131, whilst the sales reach 54,888 thousands of cubic feet. We cannot help wondering of what the extra 4757 thousand cubic feet—in round numbers one-tenth of the yearly production—consisted of and how they were obtained.

In Scotland the illuminating power runs higher; the minimum is 25 candle power, 30 is a not unfrequent figure, whilst Maryhill heads the list with 48½, and this at the modest price of 3s. 3d. to 3s. 6d. Whether these results are due to superior skill in management or to the greater productiveness of Scotch coal we do not learn.

In Ireland the illuminating power is much the same as in England, the maximum being Larne, with 22 candle power, and the minimum Carlow, Killarney, and Newtownards, with 14.

The last section of the work is somewhat complicated, including Colonial, Continental, and American returns. The highest illuminating power, 30, is reached by the Fulton Company, of Brooklyn. Nine towns, chiefly in the United States, are supplied with "water-gas," two with naphtha-gas, and to one is appended the remark "naphtha and coal-steam gas." We can only hope that this is not the product obtained by passing steam over ignited coal, and which is so rich in carbon-monoxide that in case of escape poisoning is more to be feared than explosion.

The utility of Mr. Hastings' work is beyond all question.

Water-Works Statistics, 1886. Edited by C. W. Hastings. London: The Scientific Publishing Company, Limited.

This annual work might—at least if the requisite information were procurable—be made a most valuable document for sanitarians and medical practitioners. The "source of supply" might in all cases, as it does in some, show the geological character of the drainage area, or of the ground in which the wells are sunk or the streams flow. We see with reference to some towns mention of "wells in the chalk," "wells in the sandstone," "greensand," "limestone," "springs in millstone grit," "inferior oolite," &c.

If other towns would give similarly explicit answers we have no doubt that the editor would gladly make use of the information supplied. At present these statistics throw but a very faint light on the quality of the water supplied, which both for sanitary and for trade purposes is a question of the first importance. Instead of the column headed "gravitation or pumping," which is a point of wonderfully little interest to the public, we should suggest that the hardness of the waters should be given, and by its side a column showing the death-rate of the district. We should thus be in possession of a very valuable mass of evidence showing the relative sanitary value of hard and soft waters.

Bulletin No. 4, Sugar Experiment Station, Kenner, Louisiana, and State Experiment Station, Baton Rouge, Louisiana. By W. C. Stubbs, Ph.D., Director. Issued by Thompson J. Bird, Commissioner of Agriculture. Baton Rouge: Jastremski, State Printer.

This report does not, as might be inferred from a cursory glance at the title, refer to sugar growing, but treats of the cultivation of oats, especially in the southern portion of the United States. In those regions it has been hitherto kept in check by rust. Varieties have, however, been raised which are proof against this disease, and these Dr. Stubbs recommends for culture in Louisiana, using a dressing of 2 parts cotton-seed meal (of course after the removal of the oil) and 1 part superphosphate at the rate of 400 to 500 lbs. per acre. It appears that oats are the third cereal in importance in the United States, the yearly production amounting to 407,858,999 bushels.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ciii., No. 6, August 9, 1886.

Spectrum of the Negative Pole of Nitrogen. General Law of the Distribution of Rays in Band Spectra.—H. Deslandres.—(See p. 100).

Critical Temperatures and Pressures of Certain Vapours.—C. Vincent and J. Chappuis.—The author's results are given in the form of tables. The figures confirm their conclusions that the differences between the critical temperatures and the boiling-points are not constant for series of homologous bodies, but increase progressively. They enable us, further, to see that for isomeric bodies neither the critical temperatures nor the excess of such temperatures over the boiling-points are constant.

Variations of Solubility of Certain Chlorides in Water in Presence of Hydrochloric Acid.—Guillaume Jeannel.—From an examination of the author's numerical results it appears that for one and the same chloride the quantities of salt and of acid contained in a given volume of the solution may vary in considerable proportions without the sum of the equivalents changing by more than some thousandth parts. This sum is still the same, within some thousandths, whatever may be the chloride considered. Generally speaking the sum of the equivalents increases at first in proportion as the quantity of acid augments, attains a maximum, and diminishes slightly. The author proposes the following general law:—The solubility of chlorides which hydrochloric acid precipitates from the aqueous solution varies, in presence of this acid, in such a manner that the sum of the equivalents of water, of salt, and of acid forming the solution remains constant at the same temperature, whatever may be the chloride and whatever the proportions of the mixture.

Combinations of Ammonia with the Metallic Permanganates.—T. Klobb.—The author describes compounds of this class obtained by the direct addition of ammonia to silver, copper, cadmium, nickel, zinc, and magnesium permanganates. Cobaltous salts do not give a similar compound on account of the facility with which they are oxidised. The author has succeeded in preparing an ammoniacal cobaltic permanganate.

Chemical and Thermic Study of the Phenol-sulphuric Acids. Paraphenol-sulphuric Acid.—S. Allain-le-Canu.—Paraphenol-sulphuric acid forms colourless, hydrated, very deliquescent needles. The author has prepared its mono-potassium salt and its bromo-derivatives.

Presence of Lecithine in Plants.—E. Heckel and Fr. Schlagdenhauffen.—The authors have detected the presence of the decomposition products of lecithine in a number of vegetable preparations. These facts establish a new link between the animal and vegetable worlds. They confirm once more the great truth of the vital unity proclaimed by Claude Bernard, to which is now added the unity of evolution and of organic composition.

Brandy Free from Taste Manufactured from the Marc of White Wines.—Alph. Rommier.—Not suitable for abstraction.

Journal de Pharmacie et de Chimie. Series 5, Vol. xiv., No. 2, July 15, 1886.

On Sparteine and its Salts.—MM. Grandval and Valser.—The authors give the following new reaction:—In a watch-glass they place a drop of sulphuretted ammonium sulphide, and introduce a little sparteine or a particle of one of its salts. In an instant a permanent orange-red colouration appears. They have further examined the basic, neutral, and acid sparteine sulphates, as well as the hydriodate, hydrobromate, and hydrochlorate.

Constitution of Pylocarpine.—MM. Hardy and Calmels.—The authors give structural formulæ for pilocarpine, pilocarpidine, jaborine, and jaboric acid.

Vernine.—MM. Schulze and Boschard.—Vernine is a nitrogenous crystalline matter which may be extracted from *Vicia sativa*, *Pinus sylvestris*, &c. It is sparingly soluble in cold water, very soluble in boiling water, insol-

luble in alhohol. It dissolves readily in ammonia and in dilute nitric and hydrochloric acids. If a small quantity is evaporated with dilute nitric acid there remains a yellow spot, which if touched with ammonia passes to an intense red.

The Detection of Acid Magenta in Wines.—M. Sambuc.—A continuation of the author's controversy with M. Cazeneuve.

Physiological Effects of Kairine.—Morohovetz.—From the *Weekly Medical Review*.

Chemical Action of Bacterium Aceti.—Adrian Brown.—From the CHEMICAL NEWS.

Nature of Pepsine.—Karl Sundberg.—The author infers from his researches that pepsine is probably not of an albumenoid nature.

Importation of Nitrogen into France.—M. Suilliot.—The importations of nitrogen into France in its three principal forms—sodium nitrate, ammonium sulphate, and guano—represent a mean annual value of 28 million francs. Paris alone throws into the sewers nitrogen of the yearly value of 20 millions.

Determination of Calcium Nitrate contained in *Crude* Saltpetre.—P. Guyot.—Ten grms. of the sample are dissolved in distilled water, and a few drops of the alcoholic solution of phenol-phthaleine are added. The colourless mixture is heated to a boil and titrated with Decroizille's normal sodium carbonate, heating after every fresh addition of the alkaline salt. The rose colouration produced on adding the carbonate disappears when all the lime has passed into the state of calcium carbonate, the last drop giving a colouration which is stable at a boiling heat. It is then merely requisite to multiply the number of divisions corresponding to 5 grms. by the coefficient 1,673,517·5. The lime and the nitric acid are found separately by using the coefficients :—

Lime	571,445
Nitric acid	1,102,072·5
Calcium nitrate	1,673,517·5

Resistance of Colchicine to Putrefaction.—J. Ogier. Three dogs were poisoned with colchicine; one with ·50 grm. administered hypodermically, another with 0·10 grm. administered in the same way, and the third with ·50 grm. introduced into the stomach. All were exhumed after 5½ months, and examined. The first carcase was in much better state of preservation than the second, and especially than the third, but in all the reactions of colchicine were distinctly obtained, though somewhat modified. Hence the author suggests that it is not colchicine which was extracted from the bodies, but a transformation-product presenting analogous reactions. Similar observations may apply to other alkaloids.

Production of Vanilline from the Resin of the Olive Tree.—A. Scheidel.—This resin yields vanilline if oxidised by permanganate in an alkaline solution. Before complete oxidation the mixture is oxidised with sulphuric acid, and the vanilline is extracted either with a current of steam or by agitation with ether.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. xix., No. 4.

Condensation of Chloral Hydrate with Tertiary Aromatic Amines.—P. Boessneck.—In this second communication the author investigates the condensation of chloral hydrate with dimethylaniline, the synthesis of tetramethyl-paraleukaniline and the condensation of chloral hydrate with diethylaniline.

On Cholic Acid.—F. Mylius.—After prolonged researches, as here laid down, the author concludes that cholic acid contains, along with the carboxyl group, at least one hydroxyl, as appears from the formation of glisin, its last anhydride.

Chemical Association of Sulphuric Acid with Water, Judged according to the Changes of the Specific Gravity.—D. Mendeleeff.—This paper does not admit of reproduction without the three accompanying diagrams.

On Levulose.—A. Herzfeld and H. Winter.—Levulose as obtained by crystallisation from absolute alcohol has the composition $C_6H_{12}O_6$, and its watery solution deflects the polarised ray of light by $\alpha(D) = -71·4°$.

Combinations of Perchlormethyl-mercaptan and Aniline or Toluidine.—B. Rathke.—With aniline the ultimate results of the reaction are triphenylguanidine, thiocarbanilide, and thioaniline. With toluidine the results are analogous.

Preparation of Methyl Violet by Means of Perchlormethyl-mercaptan.—B. Rathke.—Not adapted for useful abstraction.

Liberation of Heat as a Sign of the Association of Sulphuric Acid and Water.—D. Mendeleeff.—This paper requires the accompanying diagram and tables.

A Case of the Formation of Succinic-ethylester.—O. Davidoff.—The ester obtained by Prof. v. Richter is in fact a succinic ethylester. The melting-point of succinic acid as given in the text-books, viz., 180·5°, is incorrect; it should be 185°.

On Diparaxylyl-keton.—K. Elbs and G. Olberg.—The authors obtain this compound from paraxylol and phosgene in presence of aluminium chloride. It is a thick pale yellow liquid, boiling at 325° to 327°, and not congealing in the cold of winter. It is soluble in alcohol, ether, benzol, and petroleum ether. On reduction with zinc-powder and alcoholic potassa it yields diparaxylylcarbinol.

A Correction.—M. Nencki and N. Sieber.—The authors find that previous to them Prof. Hüfner of Tubingen has isolated the crystals of reduced venous hæmoglobine.

Oxidation of Phthalic Alcohol.—E. v. Hjelt.—On heating orthoxylenyl chloride with water there is formed an oil, probably orthophthalic aldehyd, which gives with ammonia an intense blue compound. The colouring-matter dissolves in chloroform with a greenish-blue and in strong sulphuric acid with a violet-blue colour. It has no distinct absorption-spectrum.

Phthalide from Orthotoluylic Acid.—E. v. Hjelt.—The direct conversion of orthotoluylic acid has not hitherto been carried out. It may be very easily effected by the action of bromine at 140°.

Meta-nitro.cumenyl-acrylic Acid and its Derivatives—Oskar Widman.—We have here an account of the salts of this acid, of meta-amido-cumenyl-acrylic acid, of meta-acetamido-cumenyl-acrylic acid, diacetamido-cumenyl-acrylic acid, meta-oxycumenyl-acrylic acid, meta-nitro-cumenyl-acrylic acid dibromide, meta-amido-cumenyl-propionic acid, and meta-acetamido-cumenyl-propionic acid.

Appendix to Memoir on Drying Apparatus.—Victor Meyer.—(See *Berichte*, xviii., p. 2999.) The liquids used for heating must be perfectly pure. The porcelain insets have been found unnecessary and even disturbing.

On a Base Isomeric with Benzidine formed on passing Aniline Vapour through Ignited Tubes.—A. Bernthsen.—The thick oil obtained as one of the products yields, on fractionate distillation with superheated steam, a base externally similar to benzidine and having the same percentage composition, though differing in its reactions. With potassium ferricyanide, unlike benzidine, it yields no reaction. Weak chlorine water gives a brown precipitate, whilst with benzidine it yields a splendid blue solution, turning first greenish blue and then red. Hence the author gives to the new base the name of iso-

benzidine. Bernthsen has further examined the mother-liquor remaining after the separation of isobenzidine.

On the Crystalline Forms of certain Derivatives of Acridine.—A. Bernthsen.—This paper is useless without the accompanying diagrams.

On Succinylosuccinic Ether.—A. Baeyer.—The author gives an account of paradioxy-terephthalic ether, of paradiamido-terephthalic ether, and of the reproduction of succinylosuccinic ether from dioxy-terephthalic ether.

On Malto-dextrine; a Reply to H. A. Herzfeld.—H. T. Brown.—A question of priority.

On Orthophenyl-diacrylic Acid.—W. H. Perkin, jun.—A brief notice of observations which will be published in detail in the *Journal of the Chemical Society*.

Attempts at the Synthesis of Coniine.—A. Ladenberg.—The author has obtained a base which is very probably identical with coniine.

Eurhodines: A new Class of Colouring-Matters.—O. N. Witt.—This interesting memoir does not admit of useful abridgment.

Carbamin-cyamides.—A. Wunderlich.—Poensgen's amidodicyanic acid behaves in all respects like a cyanamide, in which an atom of hydrogen is replaced by the group $CONH_2$.

On Actions of Contact.—D. Mendeleeff.—Not susceptible of abstraction.

Revue Universelle des Mines, de la Metallurgie, &c., Vol. xix., No. 3, May and June, 1886.

This issue contains no chemical matter.

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THE CHEMICAL NEWS.

Vol. LIV. No. 1397.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Birmingham Meeting, September 1, 1886.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir J. William Dawson, C.M.G., M.A., LL.D., F.R.S., F.G.S., Principal and Vice-Chancellor of McGill University, Montreal, Canada.*

Twenty-one years have passed away since the last meeting of the British Association in this great central city of England. At the third Birmingham meeting—that of 1865—I had the pleasure of being present, and had the honour of being one of the Vice-Presidents of Section C. At that meeting my friend John Phillips, one of the founders of the Association, occupied the Presidential chair, and I cannot better introduce what I have to say this evening than by the eloquent words in which he then addressed you:—"Assembled for the third time in this busy centre of industrious England, amid the roar of engines and clang of hammers, where the strongest powers of nature are trained to work in the fairy chains of art, how softly and fittingly falls upon the ear the accent of science, the friend of that art, and the guide of that industry! Here where Priestley analysed the air, and Watt obtained the mastery over steam, it well becomes the students of nature to gather round the standard which they carried so far into the fields of knowledge. And when on other occasions we meet in quiet colleges and academic halls, how gladly welcome is the union of fresh discoveries and new inventions with the solid and venerable truths which are there treasured and taught. Long may such union last; the fair alliance of cultivated thought and practical skill; for by it labour is dignified and science fertilised, and the condition of human society exalted." These were the words of a man who, while earnest in the pursuit of science, was full of broad and kindly sympathy for his fellow-men, and of hopeful confidence in the future. We have but to turn to the twenty Reports of this Association, issued since 1865, to see the realisation of that union of science and art to which he so confidently looked forward, and to appreciate the stupendous results which it has achieved. In one department alone—that to which my predecessor in this chair so eloquently adverted in Aberdeen, the department of education in science—how much has been accomplished since 1865. Phillips himself lived to see a great revolution in this respect at Oxford. But no one in 1865 could have anticipated that immense development of local schools of science of which your own Mason College and your admirable technical, industrial, and art schools are eminent examples. Based on the general education given by the new system of Board schools, with which the name of the late W. E. Forster will ever be honourably connected, and extending its influence upward to special training and to the highest university examinations, this new scientific culture is opening paths of honourable ambition to the men and women of England scarcely dreamed of in 1865. I sympathise with the earnest appeal of Sir Lyon Playfair, in his Aberdeen address, in favour of scientific education; but visiting England at rare intervals, I am naturally more impressed with the progress that has been made than with the vexatious delays which have occurred, and am perhaps better able to appreciate the vast strides that have been taken in the direction of that complete and all-pervading culture in science which he has so ably advocated.

No one could have anticipated twenty years ago that a Birmingham manufacturer, in whose youthful days there were no schools of science for the people, was about to endow a college, not only worthy of this great city, but one of its brightest ornaments.* Nor could anyone have foreseen the great development of local scientific societies, like your Midland Institute and Philosophical Society, which are now flourishing in every large town and in many of those of less magnitude. The period of twenty-one years that has elapsed since the last Birmingham meeting has also been an era of public museums and laboratories for the teaching of science, from the magnificent national institutions at South Kensington and those of the great universities and their colleges down to those of the schools and field clubs in country towns. It has besides been an era of gigantic progress in original work and in publication—a progress so rapid that workers in every branch of study have been reluctantly obliged to narrow in more and more their range of reading and of effort to keep abreast of the advance in their several departments. Lastly these twenty-one years have been characterised as the "coming of age" of that great system of philosophy with which the names of three Englishmen, Darwin, Spencer, and Wallace, are associated as its founders. Whatever opinions one may entertain as to the sufficiency and finality of this philosophy there can be no question as to its influence on scientific thought. On the one hand it is inaccurate to compare it with so entirely different things as the discovery of the chemical elements and of the law of gravitation; on the other, it is scarcely fair to characterise it as a mere "confused development" of the mind of the age. It is indeed a new attempt of science in its maturer years to grapple with those mysterious questions of origins which occupied it in the days of its infancy, and it is to be hoped that it may not, like the Titans of ancient fable, be hurled back from heaven, or like the first mother find the knowledge to which it aspires a bitter thing. In any case we should fully understand the responsibility which we incur when in these times of full-grown science we venture to deal with the great problem of origins, and should be prepared to find that in this field the new philosophy, like those which have preceded it, may meet with very imperfect success. The agitation of these subjects has already brought science into close relations, sometimes friendly, sometimes hostile, it is to be hoped in the end helpful, with those great and awful questions of the ultimate destiny of humanity, and its relations to its Creator, which must always be nearer to the human heart than any of the achievements of science on its own ground. In entering on such questions we should proceed with caution and reverence, feeling that we are on holy ground, and that though, like Moses of old, we may be armed with all the learning of our time, we are in the presence of that which while it burns is not consumed; of a mystery which neither observation, experiment, nor induction can ever fully solve.

In a recent address the late President of the Royal Society called attention to the fact that within the lifetime of the older men of science of the present day, the greater part of the vast body of knowledge included in the modern sciences of physics, chemistry, biology, and geology, has been accumulated, and the most important advances made in its application to such common and familiar things as the railway, ocean navigation, the electric telegraph, electric lighting, the telephone, the germ theory of disease, the use of anæsthetics, the processes of metallurgy, and the dyeing of fabrics. Even

* Abstract.

* It was in 1865 that Sir Josiah Mason was, quietly and without any public note, beginning to lay the foundation of his orphanage at Erdington.

since the last meeting in this city, much of this great work has been done, and has led to general results of the most marvellous kind. What at that time could have appeared more chimerical than the opening up by the enterprise of one British colony of a shorter road to the East by way of the extreme west, realising what was happily called by Milton and Cheadle "the new North-west passage," making Japan the next neighbour of Canada on the west, and offering to Britain a new way to her Eastern possessions; or than the possibility of this Association holding a successful meeting on the other side of the Atlantic? To have ventured to predict such things in 1865 would have appeared quite visionary, yet we are now invited to meet in Australia, and may proceed thither by the Canadian Pacific Railway and its new lines of steamers, returning by the Suez Canal.* To-day this is quite as feasible as the Canadian visit would have been in 1865. It is science that has thus brought the once widely separated parts of the world nearer to each other, and is breaking down those geographical barriers which have separated the different portions of our widely extended British race. Its work in this is not yet complete. Its goal to-day is its starting point to-morrow. It is as far as at any previous time from seeing the limit of its conquests, and every victory gained is but the opening of the way for a farther advance.

By its visit to Canada the British Association has asserted its imperial character, and has consolidated the scientific interests of Her Majesty's dominions, in advance of that great gathering of the industrial products of all parts of the empire now on exhibition in London, and in advance of any political plans of Imperial federation.† There has even been a project before us for an international scientific convention, in which the great English republic of America shall take part, a project the realisation of which was to some extent anticipated in the fusion of the members of the British and American Associations at Montreal and Philadelphia in 1884. As a Canadian, as a past President of the American Association, and now honoured with the Presidency of this Association, I may be held to represent in my own person this scientific union of the British Islands, of the various Colonies and of the great Republic, which, whatever the difficulties attending its formal accomplishment at present, is certain to lead to an actual and real union for scientific work. In furtherance of this I am glad to see here to-day influential representatives of most of the British Colonies, of India, and of the United States. We welcome here also delegates from other countries, and though the barrier of language may at present prevent a larger union, we may entertain the hope that Britain, America, India, and the Colonies, working together in the interest of science, may ultimately render our English tongue the most general vehicle of scientific thought and discovery, a consummation of which I think there are, at present, many indications.

But, while science marches on from victory to victory, its path is marked by the resting places of those who have fought its battles and assured its advance. In looking back to 1865 there rise before me the once familiar countenances of Phillips, Murchison, Lyell, Forbes, Jeffreys, Jukes, Rolleston, Miller, Spottiswoode, Fairbairn, Gassiot, Carpenter, and a host of others, present in full vigour at that meeting, but no more with us. These were veterans of science; but, alas! many then young and rising in fame are also numbered with the dead. It may be that before another Birmingham meeting many of us, the older members now, will also have passed away. But these men have left behind them ineffaceable monuments of their work, in which they still survive, and we rejoice to believe that, though dead to us, they live in that company of the great and good of all ages who have entered into that unseen universe where all that is high and holy and beautiful must go on accumulating till the time of the restitution of all things. Let us follow their example and carry on their work, as God may give us power and opportunity, gathering in precious stores of knowledge and of thought, in the belief that all truth is immortal, and must go on for ever bestowing blessings on mankind. Thus will the memory of the mighty dead remain to us as a power which—

> Like a star
> Beacons from the abode where the eternal are.

I do not wish, however, to occupy your time longer with general or personal matters, but rather to take the opportunity afforded by this address to invite your attention to some topics of scientific interest. In attempting to do this I must have before me the warning conveyed by Professor Huxley, in the address to which I have already referred, that in our time science, like Tarpeia, may be crushed with the weight of the rewards bestowed on her. In other words, it is impossible for any man to keep pace with the progress of more than one limited branch of science, and it is equally impossible to find an audience of scientific men of whom anything more than a mere fraction can be expected to take an interest in any one subject. There is, however, some consolation in the knowledge that a speaker who is sufficiently simple for those who are advanced specialists in other departments, will of necessity be also sufficiently simple to be understood by the general public who are specialists in nothing. On this principle a geologist of the old school, accustomed to a great variety of work, may hope so to scatter his fire as to reach the greater part of the audience. In endeavouring to secure this end I have sought inspiration from that ocean which connects rather than separates Britain and America, and may almost be said to be an English Sea—the North Atlantic. The geological history of this depression of the earth's crust, and its relation to the continental masses which limit it, may furnish a theme at once generally intelligible and connected with great questions as to the structure and history of the earth, which have excited the attention alike of physicists, geologists, biologists, geographers, and ethnologists. Should I, in treating of these questions, appear to be somewhat abrupt and dogmatic, and to indicate rather than state the evidence of the general views announced, I trust you will kindly attribute this to the exigencies of a short address.

If we imagine an observer contemplating the earth from a convenient distance in space, and scrutinising its features as it rolls before him, we may suppose him to be struck with the fact that eleven-sixteenths of its surface are covered with water, and that the land is so unequally distributed that from one point of view he would see a hemisphere almost exclusively oceanic, while nearly the whole of the dry land is gathered in the opposite hemisphere. He might observe that the great oceanic area of the Pacific and Antarctic Oceans is dotted with islands—like a shallow pool with stones rising above its surface—as if its general depth were small in comparison with its area. He might also notice that a mass or belt of land surrounds each pole, and that the northern ring sends off to the southward three vast tongues of land and of mountain chains, terminating respectively in South America, South Africa, and Australia, towards which feebler and insular processes are given off by the Antarctic continental mass. This, as some geographers have observed,* gives a rudely three-ribbed aspect to the earth, though two of the three ribs are crowded together and form the Europ-asian mass or double continent, while the third is isolated in the single continent of America.

* It is expected that on the completion of the connections of the Canadian Pacific Railway, the time from ocean to ocean may be reduced to 116 hours, and from London to Hong Kong to twenty-seven days.

† I should note here, in connection with this, the valuable volume of "Canadian Economics," edited by Mr. D. A. P. Watt, which was one of the results of the Montreal meeting.

* Dana, "Manual of Geology," introductory part. Green, "Vestiges of a Molten Globe," has summed up these facts.

He might also observe that the northern girdle is cut across, so that the Atlantic opens by a wide space into the Arctic Sea, while the Pacific is contracted toward the north, but confluent with the Antarctic Ocean. The Atlantic is also relatively deeper and less cumbered with islands than the Pacific, which has the higher ridges near its shores, constituting what some visitors to the Pacific coast of America have not inaptly called the "back of the world," while the wider slopes face the narrower ocean, into which for this reason the greater part of the drainage of the land is poured.* The Pacific and Atlantic, though both depressions or flattenings of the earth, are, as we shall find, different in age, character, and conditions; and the Atlantic, though the smaller, is the older, and from the geological point of view, in some respects, the more important of the two.

If our imaginary observer had the means of knowing anything of the rock formations of the continents, he would notice that those bounding the North Atlantic are in general of great age, some belonging to the Laurentian system. On the other hand, he would see that many of the mountain ranges along the Pacific are comparatively new, and that modern igneous action occurs in connection with them. Thus he might be led to believe that the Atlantic, though comparatively narrow, is an older feature of the earth's surface, while the Pacific belongs to more modern times. But he would note in connection with this that the oldest rocks of the great continental masses are mostly toward their northern ends, and that the borders of the northern ring of land and certain ridges extending southwards from it constitute the most ancient and permanent elevations of the earth's crust, though now greatly surpassed by mountains of more recent age nearer the equator. Before leaving this general survey we may make one further remark. An observer looking at the earth from without would notice that the margins of the Atlantic and the main lines of direction of its mountain chains are north-east and south-west, and north-west and south-east, as if some early causes had determined the occurrence of elevations along great circles of the earth's surface tangent to the polar circles.

We are invited by the preceding general glance at the surface of the earth to ask certain questions repecting the Atlantic. (1) What has at first determined its position and form? (2) What changes has it experienced in the lapse of geological time? (3) What relations have these changes borne to the development of life on the land and in the water? (4) What is its probable future?

Before attempting to answer these questions, which I shall not take up formally in succession, but rather in connection with each other, it is necessary to state as briefly as possible certain general conclusions respecting the interior of the earth. It is popularly supposed that we know nothing of this beyond a superficial crust perhaps averaging 50,000 to 100,000 feet in thickness. It is true we have no means of exploration in the earth's interior, but the conjoint labours of physicists and geologists have now proceeded sufficiently far to throw much inferential light on the subject, and to enable us to make some general affirmations with certainty; and these it is the more necessary to state distinctly, since they are often treated as mere subjects of speculation and fruitless discussion.

(1) Since the dawn of geological science it has been evident that the crust on which we live must be supported on a plastic or partially liquid mass of heated rock, approximately uniform in quality under the whole of its area. This is a legitimate conclusion from the wide distribution of volcanic phenomena, and from the fact that the ejections of volcanoes, while locally of various kinds, are similar in every part of the world. It led to the old idea of a fluid interior of the earth, but this is now generally abandoned, and this interior heated and plastic layer is regarded as merely an under-crust.

(2) We have reason to belive, as the result of astronomical investigations,* that, notwithstanding the plasticity or liquidity of the under-crust, the mass of the earth—its nucleus as we may call it—is practically solid and of great density and hardness. Thus we have the apparent paradox of a solid yet fluid earth; solid in its astronomical relations, liquid or plastic for the purposes of volcanic action and superficial movements.†

(3) The plastic sub-crust is not in a state of dry igneous fusion, but in that condition of aqueo-igneous or hydrothermic fusion which arises from the action of heat on moist substances, and which may either be regarded as a fusion or as a species of solution at a very high temperature. This we learn from the phenomena of volcanic action, and from the composition of the volcanic and plutonic rocks, as well as from such chemical experiments as those of Daubrée, and of Tilden and Shenstone.‡

(4) The interior sub-crust is not perfectly homogeneous, but may be roughly divided into two layers or magmas, as they have been called: an upper, highly siliceous or acidic, of low specific gravity and light-coloured, and corresponding to such kinds of plutonic and volcanic rocks as granite and trachyte; and a lower, less siliceous or more basic, more dense, and more highly charged with iron, and corresponding to such igneous rocks as the dolerites, basalts, and kindred lavas. It is interesting here to note that this conclusion, elaborated by Durocher and von Waltershausen, and usually connected with their names, appears to have been first announced by John Phillips, in his "Geological Manual," and as a mere common sense deduction from the observed phenomena of volcanic action and the probable results of the gradual cooling of the earth.§ It receives striking confirmation from the observed succession of acidic and basic volcanic rocks of all geological periods and in all localities. It would even seem, from recent spectroscopic investigations of Lockyer, that there is evidence of a similar succession of magmas in the heavenly bodies, and the discovery by Nordenskiöld of native iron in Greenland basalts affords a probability that the inner magma is in part metallic.‖

(5) Where rents or fissures form in the upper crust, the material of the lower crust is forced upward by the pressure of the less supported portions of the former, giving rise to volcanic phenomena either of an explosive or quiet character, as may be determined by contact with

* Mr Mellard Reade, in two Presidential addresses before the Geological Society of Liverpool, has well illustrated this point and its geological consequence.

* Hopkins, Mallet, Sir William Thomson, and Prof. G. H. Darwin maintain the solidity and rigidity of the earth on astronomical grounds; but different conclusions have been reached by Hennessey, Delaunay, and Airy. In America Barnard and Crosby, Dutton, Le Conte, and Wadsworth have discussed these questions.

† An objection has been taken to the effect that the supposed ellipsoidal form of the equator is inconsistent with a plastic sub-crust. But this ellipsoidal form is not absolutely certain, or, if it exists, is very minute. Bonney has in a recent lecture suggested the important consideration that a mass may be slowly mobile under long-continued pressure while yet rigid with reference to more sudden movements.

‡ *Phil. Trans.*, 1884. Also Crosby in *Proc. Boston Soc. Nat. Hist.*, 1883.

§ Phillips says ("Manual of Geology," 1855, 493):—"If we regard them (the internal crystalline rocks) as acquiring solidification by cooling in zones parallel to the surface, we should have sheets of granitic and basaltic rocks generated below, the first uppermost, the last undermost, while above the several strata were produced in a series beginning at the bottom. In this sense the rocks of fusion may be called, with Lyell, *hypogens*. Certainly under particular areas of country are found evidence of the liquefaction of one set of igneous products after the solidification of others. Many dykes of basalt traversing granite show themselves to have been in fusion after the solidification of the granite." In various forms Phillips returns to this idea, as at pp. 556 and 564, in that unpretending manner which was his wont. Dr. Sterry Hunt has kindly directed my attention to the fact of Phillips's right of priority in this matter. Durocher in 1857 elaborated the theory of magmas in the *Annales des Mines*, and we are indebted to Dutton, of the United States Geological Survey, for its detailed application to the remarkable volcanic outflows of Western America.

‖ These basalts occur at Ovifak, Greenland. Andrews has found small particles of iron in British basalts. Prestwich and Judd have referred to the bearing on general geology of these facts, and of Lockyer's suggestions.

water. The underlying material may also be carried to the surface by the agency of heated water, producing those quiet discharges which Hunt has named crenitic. It is to be observed here that explosive volcanic phenomena, and the formation of cones, are, as Prestwich has well remarked, characteristic of an old and thickened crust; quiet ejection from fissures and hydro-thermal action may have been more common in earlier periods and with a thinner over crust.

(6) The contraction of the earth's interior by cooling and by the emission of material from below the over-crust, has caused this crust to press downward, and therefore laterally, and so to effect great bends, folds, and plications; and these modified subsequently by surface denudation constitute mountain chains and continental plateaus. As Hall long ago pointed out,* such lines of folding have been produced more especially where thick sediments had been laid down on the sea bottom. Thus we have here another apparent paradox, namely, that the elevations of the earth's crust occur in the places where the greatest burden of detritus has been laid down upon it, and where consequently the crust has been softened and depressed. We must beware, in this connection, of exaggerated notions of the extent of contraction and of crumpling required to form mountains. Bonney has well shown, in lectures delivered at the London Institution, that an amount of contraction, almost inappreciable in comparison with the diameter of the earth, would be sufficient; and that as the greatest mountain chains are less than 1-600th of the earth's radius in height, they would on an artificial globe a foot in diameter be no more important than the slight inequalities that might result from the paper gores overlapping each other at the edges.

(7) The crushing and sliding of the over-crust implied in these movements raise some serious questions of a physical character. One of these relates to the rapidity or slowness of such movements, and the consequent degree of intensity of the heat developed, as a possible cause of metamorphism of rocks. Another has reference to the possibility of changes in the equilibrium of the earth itself as resulting from local collapse and ridging. These questions in connection with the present dissociation of the axis of rotation from the magnetic poles, and with changes of climate, have attracted some attention,† and probably deserve further consideration on the part of physicists. In so far as geological evidence is concerned, it would seem that the general association of crumpling with metamorphism indicates a certain rapidity in the process of mountain-making, and consequent development of heat, and the arrangement of the older rocks around the Arctic basin forbids us from assuming any extensive movement of the axis of rotation, though it does not exclude changes to a limited extent. I hope that Professor Darwin will discuss these points in his Address to the Physical Section.

I wish to formulate these principles as distinctly as possible, and as the result of all the long series of observations, calculations, and discussions since the time of Werner and Hutton, and in which a vast number of able physicists and naturalists have borne a part, because they may be considered as certain deductions from our actual knowledge, and because they lie at the foundation of a rational physical geology.

We may popularise these deductions by comparing the earth to a drupe or stone-fruit, such as a plum or peach, somewhat dried up. It has a large and intensely hard stone and kernel, a thin pulp made up of two layers, an inner more dense and dark-coloured, and an outer less dense and lighter-coloured. These constitute the under-crust. On the outside it has a thin membrane or over-crust. In the process of drying it has slightly shrunk, so as to produce ridges and hollows of the outer crust, and this outer crust has cracked in some places, allowing portions of the pulp to ooze out—in some of these its lower dark substance, in others its upper and lighter material. The analogy extends no farther, for there is nothing in our withered fruit to represent the oceans occupying the lower parts of the surface or the deposits which they have laid down.

Keeping in view these general conclusions, let us now turn to their bearing on the origin and history of the North Atlantic.

Though the Atlantic is a deep ocean, its basin does not constitute so much a depression of the crust of the earth as a flattening of it, and this, as recent soundings have shown, with a slight ridge or elevation along its middle and banks or terraces fringing the edges, so that its form is not so much that of a basin as that of a shallow plate with its middle a little raised. Its true permanent margins are composed of portions of the over-crust folded, ridged up, and crushed, as if by lateral pressure emanating from the sea itself. We cannot, for example, look at a geological map of America without perceiving that the Appalachian ridges, which intervene between the Atlantic and the St. Lawrence valley, have been driven bodily back by a force acting from the east, and that they have resisted this pressure only where, as in the Gulf of St. Lawrence and the Catskill region of New York, they have been protected by outlying masses of very old rocks, as, for example, by that of the island of Newfoundland and that of the Adirondack Mountains. The admirable work begun by my friend and fellow-student, Professor James Nichol, followed up by Hicks, Lapworth, and others, and now, after long controversy, fully confirmed by the recent observations of the geological survey of Scotland, has shown the most intense action of the same kind on the east side of the ocean in the Scottish highlands; and the more widely distributed Eozoic rocks of Scandinavia may be appealed to in further evidence of this.*

If we now inquire as to the cause of the Atlantic depression, we must go back to a time when the areas occupied by the Atlantic and its bounding coasts were parts of a shoreless sea in which the earliest gneisses or stratified granites of the Laurentian age were being laid down in vastly extended beds. These ancient crystalline rocks have been the subject of much discussion and controversy, and as they constitute the lowest and probably the firmest part of the Atlantic sea-bed, it is necessary to inquire as to their origin and history. Dr. Bonney, the late President of the Geological Society, in his Anniversary address, and Dr. Sterry Hunt, in an elaborate paper communicated to the Royal Society of Canada, have ably summed up the hypotheses as to the origin of the oldest Laurentian beds. At the basis of these hypotheses lies the admission that the immensely thick beds of orthoclase gneiss, which are the oldest stratified rocks known to us, are substantially the same in composition with the upper or siliceous magma or layer of the under-crust. They are, in short, its materials either in their primitive condition or merely rearranged. One theory considers them as original products of cooling, owing their lamination merely to the successive stages of the process. Another view refers them to the waste and rearrangement of the materials of a previously massive granite. Still another holds that all our granites really arise from the fusion of old gneisses of originally aqueous origin, while a fourth refers the gneisses themselves to molecular changes effected in granite by pressure. These several views, in so far as they relate to the oldest or fundamental Laurentian gneiss, may be arranged under the following heads:—(1) *Endoplutonic*, or that which regards all the old gneisses as molten rocks cooled from without inward

* Hall (American Association Address, 1857, subsequently republished, with additions, as "Contributions to the Geological History of the American Continent," Mallet), Rogers, Dana, Le Conte, &c.

† See recent papers of Oldham and Fisher in *Geological Magazine* and *Philosophical Magazine*, July, 1886. Also Péroche, "Revol. Polaires," Paris, 1886.

* Address to the Geological Section, by Prof. Judd, Aberdeen Meeting, 1885. According to Rogers, the Crumpling of the Appalachians has reduced a breadth of 158 miles to about 60.

in successive layers.* (2) *Exoplutonic*, or that which considers them as made up of matter ejected from below the upper crust in the manner of volcanic action.† (3) *Metamorphic*, which supposes the old gneisses to arise from the crystallisation of detrital matter spread over the sea-bottom, and either igneous or derived from the decay of igneous rocks.‡ (4) *Chaotic* or *Thermo-chaotic*, or the theory of deposit from the turbid waters of a primeval ocean either with or without the aid of heat. In one form this was the old theory of Werner.‖ (5) *Crenitic* or Hydro-thermic, which supposes the action of heated waters penetrating below the crust to be constantly bringing up to the surface mineral matters in solution and depositing these so as to form felspathic and other rocks.§

It will be observed, in regard to these theories, that none of them supposes that the old gneiss is an ordinary sediment, but that all regard it as formed in exceptional circumstances, these circumstances being the absence of land and of sub-aërial decay of rock, and the presence wholly or principally of the material of the upper surface of the recently hardened crust. This being granted, the question arises, Ought we not to combine these several theories and to believe that the cooling crust has hardened in successive layers from without inward; that at the same time fissures were locally discharging igneous matter to the surface: that matter held in suspension in the ocean and matter held in solution by heated waters rising from beneath the outer crust were mingling their materials in the deposits of the primitive ocean? It would seem that the combination of all these agencies may safely be invoked as causes of the pre-Atlantic deposits. This is the eclectic position which I endeavoured to maintain in my address before the Minneapolis Meeting of the American Association in 1883, and which I still hold to be in every way probable.

A word here as to metamorphism, a theory which, like many others, has been first run to death and then discredited, but which to the moderate degree in which it was originally held by Lyell is still valid. Nothing can be more certain than that the composition of the Laurentian gneisses forbids us to suppose that they can be ordinary sediments metamorphosed. They are rocks peculiar in their origin, and not paralleled unless exceptionally in later times. On the other hand, they have undoubtedly experienced very important changes, more especially as to crystallisation, the state of combination of their ingredients, and the development of disseminated minerals;¶ and while this may in part be attributed to the mechanical pressure to which they have been subjected, it requires also the action of hydrothermic agencies. Any theory which fails to invoke both of these kinds of force must necessarily be partial and imperfect.

But all metamorphic rocks are not of the same character with the gneisses of the Lower Laurentian. Even in the Middle and Upper Laurentian we have metamorphic rocks, *e.g.* quartzite and limestone, which must originally have been ordinary aqueous deposits. Still more in the succeeding Huronian and its associated series of beds, and in the Lower Palæozoic, local metamorphic change has been undergone by rocks quite similar to those which in their unaltered state constitute regular sedimentary deposits. In the case of these later rocks it is to be borne in mind that, while some may have been of volcanic origin, others may have been sediments rich in undecomposed fragments of silicates. It is a mistake to suppose that the ordinary decay of stratified siliceous rocks is a process of kaolinisation so perfect as to eliminate all alkaline matters. On the contrary, the fact, which Judd has recently well illustrated in the case of the mud of the Nile, applies to a great number of similar deposits in all parts of the world, and shows that the finest sediments have not always been so completely lixiviated as to be destitute of the basic matters necessary for their conversion into gneiss, mica-schist, and similar rocks when the necessary agencies of metamorphism are applied to them, and this quite independently of any extraneous matters introduced into them by water or otherwise. Still it must be steadily kept in view that many of the old pre-Cambrian crystalline rocks must have been different originally from those succeeding them, and that consequently these last even when metamorphosed present different characters.

(To be continued.)

* Naumann, Phillips, Durocher, McFarlane, &c.
† Clarence King, Tornebohm, Marr, &c.
‡ Lyell, Kopp, Reusch, Judd, &c.
§ Scrope, Delabeche, Daubrée.
‖ Hunt, *loc. cit.* The following is Dr. Hunt's summary statement of this theory:—"The globe consolidating at the centre left, it is conceived, a superficial layer of basic silicates, which has yielded all the fixed elements of the earth's crust. This layer formed the first land and the floor of the primeval sea, the acid waters of which, fermenting and partially decomposing it, became thereby chemically neutralised. This last-cooled layer, mechanically disintegrated, saturated with water, and heated by the central mass, was the source of mineral springs, holding in solution the silicates which built up the ancient gneisses and similar rocks. Granitic veins and zeolites are due to survivals of the process which generated the gneissic rocks. The hypothesis of their formation from materials brought to the surface by mineral springs from the primitive basic layer affords, it is claimed, the elements of a complete and intelligible explanation of the origin of the Eozoic rocks. This upward lixiviation of the primitive mass, and the deposition over it of an acidic granite-like rock, would leave below a highly basic material, and the division of the mass thus established would correspond to that of the trachytic and doleritic magmas, which have been conjectured to be the sources of two great types of eruptive rocks. Inasmuch, however, as according to the present hypothesis these two layers of basic and acidic matters are the results of aqueous action, and not of an original separation in a plutonic mass, as imagined by Phillips and Durocher, their composition would be subject to many local variations."
¶ The first of these is what Bonney has called *Metastasis*. The second and third come under the name *Metacrasis*. *Methylosis*, or change of substance, is altogether exceptional, and not to be credited except on the best evidence, or in cases where volatile matters have been 'expelled,' as in the change of hematite into magnetite, or of bituminous coal into anthracite.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.,
President of the Section.

A GLANCE over the Presidential Addresses delivered before this Section on former occasions will show that the occupiers of this chair have ranged over a fairly wide field. Some of my predecessors have given a general survey of the progress of chemical science during the past year; some, taking up a technological aspect of the subject, have discussed the bearings of chemistry upon our national industries; others, again, have passed in review the various institutions in this country for teaching chemistry; and in yet other cases the speaker has had the opportunity of bringing before the scientific world, for the first time, an account of some important original researches.

On this occasion I venture to ask your attention to a few thoughts on the very foundations of chemistry as a science,—on the nature and the probable, or at least possible, origin of the so-called elements. If the views to which I have been led may at first glance appear heretical, I must remind you that in some respects they are shared more or less, as I shall subsequently show, by not a few of the most eminent authorities, and notably by one of my predecessors in this chair, Dr. J. H. Gladstone, F.R.S., to whose brilliant address, delivered in 1883, I must beg to refer you.

Should it not sometimes strike us, chemists of the present day, that after all we are in a position unpleasantly akin to that of our forerunners, the alchemists of the Middle Ages? These necromancers of a time long past did not, indeed, draw so sharp a line as do we between bodies

* Delivered Thursday, September 2nd, 1886.

simple and compound; yet their life-task was devoted to the formation of new combinations, and to the attempt to transmute bodies which we commonly consider as simple and ultimate,—that is, the metals. In the department of synthesis they achieved very considerable successes; in the transmutation of metals their failure is a matter of history.

But what are we of this so-called Nineteenth Century doing in our laboratories and our libraries? Too many of us are content to acquire simply what others have already observed and discovered, with an eye directed mainly to medals, certificates, diplomas, and other honours recognised as the fruits of "passing." Others are seeking to turn the determined facts of chemistry to useful purposes; whilst a third class, sometimes not easily distinguished from the second, are daily educing novel organic compounds, or are racking their ingenuity to prepare artificially some product which Nature has hitherto furnished us through the instrumentality of plants and animals. The practical importance of such investigations, and their bearing on the industrial arts and on the purposes and needs of daily life, have been signally manifested during the last half century.

Still a fourth class of inquirers working at the very confines of our knowledge, find themselves occasionally at least face to face with a barrier which has hitherto proved impassable, but which must be overthrown, surmounted, or turned if chemical science is ever to develope into a definite, an organised unity. This barrier is nothing less than the chemical elements commonly so called, the bodies as yet undecomposed into anything simpler than themselves. There they extend before us, as stretched the wide Atlantic before the gaze of Columbus, mocking, taunting, and murmuring strange riddles, which no man yet has been able to solve.

The first riddle, then, which we encounter in chemistry is "What are the elements"? Of the attempts hitherto made to define or explain an element none satisfy the demands of the human intellect. The text-books tell us that an element is "a body which has not been decomposed;" that it is "a something to which we can add, but from which we can take away nothing," or "a body which increases in weight with every chemical change." Such definitions are doubly unsatisfactory: they are provisional, and may cease to-morrow to be applicable in any given case. They take their stand, not on any attribute of the things to be defined, but on the limitations of human power; they are confessions of intellectual impotence.

Just as to Columbus long philosophic meditation led him to the fixed belief of the existence of a yet untrodden world beyond that waste of Atlantic waters, so to our most keen-eyed chemists, physicists, and philosophers a variety of phenomena suggest the conviction that the elements of ordinary assumption are not the ultimate boundary in this direction, of the knowledge which man may hope to attain. Well do I remember, soon after I had obtained evidence of the distinct nature of thallium, that Faraday said to me—"To discover a new element is a very fine thing, but if you could decompose an element and tell us what it is made of,—that would be a discovery indeed worth making." And this was no new speculation of Faraday's, for in one of his early lectures he remarked—"At present we begin to feel impatient, and to wish for a new state of chemical elements. For a time the desire was to add to the metals, now we wish to diminish their number. . . . To decompose the metals, then, to reform them, to change them from one to another, and to realise the once absurd notion of transmutation are the problems now given to the chemist for solution."

Mr. Herbert Spencer, in his hypothesis of the constitution of matter, says:—"All material substances are divisible into so-called elementary substances composed of molecular particles of the same nature as themselves; but these molecular particles are complicated structures consisting of congregations of truly elementary atoms, identical in nature and differing only in position, arrangement, motion, &c., and the molecules or chemical atoms are produced from the true or physical atoms by processes of evolution under conditions which chemistry has not yet been able to reproduce."

Mr. Norman Lockyer has shown, I think on good evidence, that, in the heavenly bodies of the highest temperature, a large number of our reputed elements are dissociated, or, as it would perhaps be better to say, have never been formed. Mr. Lockyer holds that "The temperature of the sun and the electric arc is high enough to dissociate some of the so-called chemical elements, and give us a glimpse of the spectra of their bases"; and he likewise says that "A terrestrial element is an exceedingly complicated thing that is broken up into simpler things at the temperature of the Sun, and some of these things exist in some sun-spots, while other constituents exist in others."

The late Sir Benjamin Brodie, in a lecture on Ideal Chemistry delivered before the Chemical Society in 1867, goes even further than this. He says:—"We may conceive that, in remote time or in remote space, there did exist formerly, or possibly do exist now, certain simpler forms of matter than we find on the surface of our globe—a, χ, ξ, ν, and so on. . . . We may consider that in remote ages the temperature of matter was much higher than it is now, and that these other things existed then in the state of perfect gases—separate existences—uncombined. . . . We may then conceive that the temperature began to fall, and these things to combine with one another and to enter into new forms of existence, appropriate to the circumstances in which they were placed. . . . We may further consider that, as the temperature went on falling, certain forms of matter became more permanent and more stable, to the exclusion of other forms. . . . We may conceive of this process of the lowering of the temperature going on, so that these substances, when once formed, could never be decomposed—in fact, that the resolution of these bodies into their component elements could never occur again. You would then have something of our present system of things. . . .

"Now this is not purely an imagination, for when we look upon the surface of our globe we have actual evidence of similar changes in Nature. . . . When we look at some of the facts which have been revealed to us by the extraordinary analyses which have been made of the matter of distant worlds and nebulæ, by means of the spectroscope, it does not seem incredible to me that there may even be evidence, some day, of the independent existence of such things as χ and ν."

In his Burnett Lectures "On Light as a Means of Investigation," Professor Stokes, speaking of a line in the spectrum of the nebulæ, says:—"It may possibly indicate some form of matter more elementary than any we know on earth. There seems no *d priori* improbability in such a supposition so great as to lead us at once to reject it. Chemists have long speculated on the so-called elements, or many of them, being merely very stable compounds of elements of a higher order, or even perhaps of a single kind of matter."

In 1868, Graham wrote of Sir W. Thomson's vortex-ring theory, as enlivening "matter into an individual existence and constituting it a distinct substance or element."

From these passages, which might easily be multiplied, it plainly appears that the notion—not necessarily of the decomposability, but at any rate of the complexity of our supposed elements—is, so to speak, in the air of science, waiting to take a further and more definite development. It is important to keep before men's minds the idea of the genesis of the elements; this gives some form to our conceptions, and accustoms the mind to look for some physical production of atoms. It is still more important, too, to keep in view the great probability that these exist

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in Nature laboratories where atoms are formed and laboratories where atoms cease to be. We are on the track and are not daunted, and fain would we enter the mysterious region which ignorance tickets "Unknown." It is for us to strive to unravel the secret composition even of the so-called elements,—to undauntedly persevere,—and "still bear up right onward."

If we adopt the easy-going assumption that the elements, whether self-existent or created, are absolutely and primordially distinct; that they existed as we now find them prior to the origin of stars and their attendant planets, constituting, in fact, the primal "fire-mist," we are little, if any, the wiser. We look at their number and at their distinctive properties, and we ask, Are all these points accidental or determinate? In other words, might there as well have been only 7, or 700, or 7000 absolutely distinct elements as the 70 (in round numbers) which we now commonly recognise? The number of the elements does not, indeed, commend itself to our reason from any *à priori* or extraneous considerations. Might their properties have conceivably differed from those which we actually observe? Are they formed by a "fortuitous concatenation," or do they constitute together a definite whole, in which each has its proper part to play, and from which none could be extruded without leaving a recognizable deficiency?

If their peculiarities were accidental it would scarcely be possible for the elements to display those mutual relations which we find brought into such prominent light and order in the periodic classification of Newlands, Mendeleeff, and Meyer. Has not the relation between the atomic weights of the three halogens, chlorine, bromine, and iodine, and their serially varying properties, physical and chemical, been worn nearly threadbare? And the same with the calcium and the sulphur groups? Surely the probability of such relations existing among some 70 bodies which had come into fortuitous existence would prove to be vanishingly small!

We ask whether these elements may not have been evolved from some few antecedent forms of matter,—or possibly from only one such—just as it is now held that all the innumerable variations of plants and animals have been developed from fewer and earlier forms of organic life? As Dr. Gladstone well puts it, they "have been built up one from another, according to some general plan." This building up, or evolution, is above all things not fortuitous: the variation and development which we recognise in the universe run along certain fixed lines which have been preconceived and foreordained. To the careless and hasty eye design and evolution seem antagonistic; the more careful inquirer sees that evolution, steadily proceeding along an ascending scale of excellence, is the strongest argument in favour of a preconceived plan.

The array of the elements cannot fail to remind us of the general aspect of the organic world. In both cases we see certain groups well filled up, even crowded with forms having among themselves but little specific difference. On the other hand, in both, other forms stand widely isolated. Both display species that are common and species that are rare; both have groups widely distributed,—it might be said cosmopolitan, and other groups of very restricted occurrence. Among animals I may mention as instances the Monotremata of Australia and New Guinea, and among the elements the metals of the so-called rare earths.

Now as these facts in the distribution of organic forms are generally considered by biological experts to rank among the weightiest evidences in favour of the origin of species by a process of evolution, it seems natural, in this case as in the other, to view existing elements not as primordial but as the gradual outcome of a process of development, possibly even of a "struggle for existence." Bodies not in harmony with the present general conditions have disappeared or perhaps have never existed. Others—the asteroids among the elements—have come into being and have survived, but only on a limited scale; whilst a third class are abundant because surrounding conditions have been favourable to their formation and preservation.

The analogy here suggested between elements and organisms is, indeed, not the closest, and must not be pushed too far. From the nature of the case there cannot occur in the elements a difference corresponding to the difference between living and fossil organic forms. The "great stone book" can tell us nothing of extinct elements. Nor would I for a moment suggest that any one of our present elements, however rare, is like a rare animal or plant in process of extinction; that any new element is in the course of formation, or that the properties of existing elements are gradually undergoing modification. All such changes must have been confined to that period so remote as not to be grasped by the imagination, when our Earth, or rather the matter of which it consists, was in a state very different from its present condition. The epoch of elemental development is decidedly over, and I may observe that in the opinion of not a few biologists the epoch of organic development is verging upon its close.

Making, however, every allowance for these distinctions, if evolution be a cosmic law, manifest in heavenly bodies, in organic individuals, and in organic species, we shall in all probability recognise it, though under especial aspects, in those elements of which stars and organisms are in the last resort composed.

Is there then, in the first place, any direct evidence of the transmutation of any supposed "element" of our existing list into another, or of its resolution into anything simpler?

To this question I am obliged to reply in the negative.

I doubt whether any chemist here present could suggest a process which would hold out a reasonable prospect of dissociating any of our accepted simple bodies. The highest temperatures and the most powerful electric currents at our disposal have been tried, and tried in vain. At one time there seemed a possibility at least that the interesting researches of Prof. Victor Meyer might show the two higher members of the halogen group, bromine and iodine, as entering upon the path of dissociation. These hopes have not been fulfilled. It may be said, in the general opinion of the most eminent and judicious chemists, that none of the phenomena thus elicited prove that even an approach has been made to the object in view.

Even if we leave our artificial laboratories and seek an escape from the difficulty by observing the processes of the great laboratories of nature, we feel no sufficiently firm ground.

We find ourselves thus driven to indirect evidence,—to that which we may glean from the mutual relations of the elementary bodies. Such evidence of great value is by no means lacking, and to this I now beg to direct attention. First, we may consider the conclusion arrived at by Herschel, and pursued by Clerk-Maxwell, that atoms bear the impress of manufactured articles. Let us look a little more closely at this view. A manufactured article may well be supposed to involve a manufacturer. But it does something more: it implies certainly a raw material, and probably, though not certainly, the existence of by-products, residues, paraleipomena. What or where is here the raw material? Can we detect any form of matter which bears to the chemical elements a relation like that of a raw material to the finished product, like that, say, of coal-tar to alizarin? Or can we recognise any elementary bodies which seem like waste or refuse? Or are all the elements, according to the common view, co-equals? To these questions no direct answer is as yet forthcoming.

And this leads us up to a hypothesis which, if capable of

full demonstration, would show us that the accepted elements are not co-equal, but have been formed by a process of expansion or evolution. I refer to the well-known hypothesis of Prout, which regards the atomic weights of the elements as multiples, by a series of whole numbers, of unity = the atomic weight of hydrogen. Every one is aware that the recent more accurate determinations of the atomic weights of different elements do not by any means bring them into close harmony with the values which Prout's law would require. Still, in no small number of cases the actual atomic weights approach so closely to those which the hypothesis demands, that we can scarcely regard the coincidence as accidental. Accordingly, not a few chemists of admitted eminence consider that we have here an expression of the truth, masked by some residual or collateral phenomena which we have not yet succeeded in eliminating.

The original calculations on which the most accurate numbers for the atomic weights are founded have recently been re-calculated by Mr. F. W. Clarke. In his concluding remarks, speaking of Prout's law, Mr. Clarke says that "none of the seeming exceptions are inexplicable. In short, admitting half multiples as legitimate, it is more probable that the few apparent exceptions are due to undetected constant errors than that the great number of close agreements should be merely accidental. I began this re-calculation of the atomic weights with a strong prejudice against Prout's hypothesis, but the facts as they came before me have forced me to give it a very respectful consideration."

But if the evidence in favour of Prout's hypothesis in its original guise is deemed insufficient, may not Mr. Clarke's suggestion of half multiples place it upon an entirely new basis? Suppose that the unit of the scale, the body whose atomic weight, if multiplied by a series of whole numbers, gives the atomic weights of the remaining elements, is not hydrogen, but some element of still lower atomic weight? We are here at once reminded of helium,—an element purely hypothetical as far as our earth is concerned, but supposed by many authorities, on the faith of spectroscopic observations, to exist in the sun and in other stellar bodies. Most solar eruptions present merely the characteristic lines of hydrogen C, F, and H, and along with them one particular line which at first was classed in the sodium group, but which is a little more refrangible and is designated by the symbol D_3. According to Mr. Norman Lockyer and the late Father Secchi, this ray undergoes modifications not comparable to those affecting other rays of the chromosphere. In the corresponding region of the spectrum no dark ray has been observed. That the accompanying lines C, F, and H pertain to hydrogen is evident; and as D_3 has never been obtained in any other spectrum it is supposed to belong to a body foreign to our earth, though existing in abundance in the chromosphere of the sun. To this hypothetical body the name helium is assigned.

In an able memoir on this subject read before the Academy of Brussels, the Abbé E. Spée shows that, if helium exists, it enjoys two very remarkable properties. Its spectrum consists of a single ray, and its vapour possesses no absorbent power. The simple single ray, though I believe unexampled, is by no means an impossible phenomenon, and indicates a remarkable simplicity of molecular constitution. The non-absorbent property of its vapour seems to be a serious objection to a general physical law. Professor Tyndall has demonstrated that the absorptive power increases with the complexity of molecular structure, and hence he draws the conclusion that the simpler the molecule the feebler the absorption. This conclusion the Abbé Spée regards as perfectly legitimate; but it neither explains nor even necessitates the absence of *all* absorptive power.

Granting that helium exists, all analogy points to its atomic weight being below that of hydrogen. Here, then, we may have the very element with atomic weight half that of hydrogen, required by Mr. Clarke as the basis of Prout's law.

But a more important piece of evidence for the compound nature of the chemical elements has yet to be considered. Many chemists must have been struck with certain peculiarities in the occurrence of the elements in the earth's crust; it is a stale remark that we do not find them evenly distributed throughout the globe. Nor are they associated in accordance with their specific gravities; the lighter elements placed on or near the surface, and the heavier ones following serially deeper and deeper. Neither can we trace any distinct relation between local climate and mineral distribution. And by no means can we say that elements are always or chiefly associated in Nature in the order of their so-called chemical affinities; those which have a strong tendency to form with each other definite chemical combinations being found together, whilst those which have little or no such tendency exist apart. We certainly find calcium as carbonate and sulphate, sodium as chloride, silver and lead as sulphides; but why do we find certain groups of elements with little affinity for each other yet existing in juxtaposition or commixture? The members of some of these groups are far from plentiful, not generally or widely diffused, and certainly they are not easy to separate.

As instances of such grouping we may mention:—

1. Nickel and cobalt, of which it may be said that had their compounds been colourless they would have been long regarded as identical, and possibly even yet would not have been separated.

2. The two groups of platinum metals.

3. The so-called "rare earths," occurring in gadolinite, samarskite, &c., and evidently becoming more numerous the more closely they are examined.

Certain questions here suggest themselves:—Is the series of these elements like a staircase or like an inclined plane? Will they, the more closely they are scrutinised, be found to fade away the more gradually the one into the other? Further, will a mixture hitherto held to be simple, like (*e.g.*) didymium, be capable of being split up in one direction only, or in several? I have been led to ask this last question because I have separated from didymium bodies which seems to agree neither with the praseodymium and neodymium of Dr. Auer von Welsbach, nor with the components detected by M. de Boisbaudran and M. Demarçay.

Why, then, are these respective elements so closely associated? What agency has brought them together?

An eminent physicist evades the difficulty by suggesting that their joint occurrence is simply an instance of the working of the familiar principle "Birds of a feather flock together." In their chemical and physical attributes these rare earths are so closely similar, that they may be regarded as substantially identical in all the circumstances of solution and precipitation to which they may have been exposed during Geological ages.

But do we, in point of fact, recognise any such agency at work in Nature? Is there any power which regularly and systematically sorts out the different kinds of matter from promiscuous heaps, conveying like to like and separating unlike from unlike? I must confess that I fail to trace any such distributive agency, nor, indeed, do I feel able to form any distinct conception of its nature.

I must here remark that coral worms in some cases do effect a separation of certain kinds of matter. Thus a *Gorgonia* of the species *Melithæa*, and *Mussa sinuosa*, undoubtedly eliminate from sea-water not merely lime, but even yttria; and other recent corals, *Pocillopora damicornis*, and a *Symphyllia* close to the yttria-secreting *Mussa*, separate samaria from sea-water. Sea-weeds and aquatic mollusks contain a larger proportion of iodine and bromine than the waters which they inhabit, and may thus be said to separate out these elements from the chlorine with which they are mingled.

But if we examine these cases of elimination we see that they are limited in their scope. They extend only to substances existing in solution of which there is a fresh supply always at hand, and which are capable of entering into the animal or vegetable economy. Again, the elimination of iodine and bromine, effected as just described, is of a very imperfect character, and, when such water-plants and animals die and decay, their constituents will be again distributed in the water.

We cannot well consider that nickel and cobalt have been deposited in admixture by organic agency, nor yet the groups iridium, osmium, and platinum,—ruthenium, rhodium, and palladium.

Since the earthy metals to which I have referred—such as yttrium, samarium, holmium, erbium, thulium, ytterbium, &c.—are very rare, the probability of their ever having been brought together in some few uncommon minerals discovered only in a few localities must be regarded as trifling indeed, if we suppose that these metals had at any time been widely diffused in a state of great dilution with other matter. The features which we have just recognised in these earths seem to point to their formation severally from some common material placed in conditions in each case nearly identical. The case is strengthened by a consideration of the other groups of elements, also similar in properties, having little affinity for each other and occurring in admixture; either all or at least some of the elements concerned being moreover decidedly rare. Thus we have nickel and cobalt not plentiful or widely distributed; cobalt, perhaps, never found absolutely free from nickel, and *vice versâ*. We have also the two platinum groups, where very similar features prevail.

A weighty argument in favour of the compound nature of the elements is that drawn from a consideration of the compound radicles, or, as they might be called, pseudo-elements. Their similarity with the accepted elements is perfectly familiar to all chemists. If, for example, we suppose, that in some age or in some country men of science were cognizant of the existence and of the behaviour of cyanogen, but had not succeeded in resolving it into its constituents, nothing, surely, would prevent their viewing it as an element, and assigning it a place with the halogens. It may fairly be held that if a body which we know to be compound can be found playing the part of an element, this fact lends a certain plausibility to the supposition that the elements also are not absolutely simple. This line of thought, or at least one closely approximating to it, was worked out by Dr. Carnelley in a paper read before this Association at its last meeting. From a comparison of the physical properties of inorganic with those of organic compounds, Dr. Carnelley concludes that "*the elements, as a whole, are analogous to the hydrocarbon radicals.*" This conclusion, if true, he adds, should lead to the further inference that the so-called elements are not truly elementary, being made up of at least two absolute elements, named provisionally A and B. Hence, he argues, it should be possible to build up a series of compounds of these two primary elements which would correspond to what we now call elements. Such an arrangement, to be admissible, would have to fulfil certain conditions:—The secondary elements thus generated from A and B must exhibit the phenomena of periodicity, and the series would have to form octaves; the entire system is bound to display some feature corresponding to the "odd and even series" of Mendeleeff's classification; the atomic weights must increase across the system from the first to the seventh group,—that is, from the positive to the negative end of each series; the atomicity would have to increase from the first to the middle group, and then either increase or decrease to the seventh group; some feature should appear corresponding to the eighth group; and, lastly, the atomic weights in such a system ought to agree with the atomic weights as experimentally determined.

This last condition Dr. Carnelley rightly regards as the most crucial, and he finds his arrangement gives atomic weights which in a majority of instances coincide approximately with the actual atomic weights. Thus out of a total of sixty-one elements whose atomic weights have been determined with at least approximate accuracy, and whose places in the periodic system is not disputed, twenty-seven agree almost exactly with the actual numbers, whilst nineteen others are not more than one unit astray.

For a detailed consideration of the conclusions which follow from Dr. Carnelley's views I must refer to his paper as read at our last meeting. Two points bear more especially upon the subject now under consideration,—that is, if this speculation on the genesis of the elements is well-founded. First, the existence of elements of identical atomic weights, isomeric with each other, would be possible; as such Dr. Carnelley mentions respectively nickel and cobalt (now found to have slightly different atomic weights) rhodium and ruthenium, osmium and iridium, and the metals of some of the rare earths. Secondly, in Dr. Carnelley's scheme all the chemical elements save hydrogen are supposed to be composed of two simpler elements, A = 12 and B = −2. Of these he regards A as a tetrad identical with carbon, and B as a monad of negative weight—perhaps the ethereal fluid of space.

Dr. Carnelley's three primary elements therefore are carbon, hydrogen, and the ether.

Starting from the supposition that pristine matter was once in an intensely heated condition, and that it has reached its present state by a process of free cooling, Dr. E. J. Mills suggests that the elements, as we now have them, are the result of successive polymerisations. Dr. Mills reminds us that chemical substances in the process of cooling naturally increase in density, and, if such increase be measured as a function of time or of temperature, we sometimes observe that there are critical points corresponding to the formation of new and well-defined substances. In this manner, ordinary phosphorus is converted into the red variety, I is transformed into I_2, S_2 becomes S_6, and NO_2 N_2O_4. Among organic bodies styrol, in like manner, according to Dr. Mills, is converted into metastyrol, aldehyd into paraldehyd, the cyanates into cyanurates, and turpentine into metaterebenthene. At the critical points above referred to heat is liberated in especial abundance, and the bodies thus formed are known as polymers. If we could gradually cool down substances through a vast range of temperature, we should then probably discover a much greater number of such critical points, or points of multiple proportion, than we have been able to discover experimentally.

The heat given out in the act of polymerisation naturally reverses to some extent the polymerisation itself, and so causes a partial return to the previous condition of things. This forward and backward movement, several times repeated, constitutes "periodicity." Dr. Mills regards variable stars as instances, now in evidence, of the genesis of elementary bodies.

From a study of the classification of the elements, Dr. Mills is of opinion that the only known polymers of the primitive matter are arsenic, antimony, and perhaps erbium and osmium; whilst zirconium, ruthenium, samarium, and platinum approximate to the positions of other polymers. Hence, from this genetic view, these elements may be described as products of successive polymerisations.

I must now call attention to a method of illustrating the periodic law, proposed by my friend Prof. Emerson Reynolds, of the University of Dublin, which will here assist us. Prof. Reynolds points out that in each period the general properties of the elements vary from one to another with approximate regularity until we reach the seventh member, which is in more or less striking contrast with the first element of the same period, as well as with the first of the next. Thus chlorine, the seventh member

of Mendeleeff's third period, contrasts sharply both with sodium, the first member of the same series, and with potassium, the first member of the next series, whilst, on the other hand, sodium and potassium are closely analogous. The six elements whose atomic weights intervene between sodium and potassium vary in properties, step by step, until chlorine, the contrast to sodium, is reached. But from chlorine to potassium, the analogue of sodium, transition-element to exhibit. If we examine a particular period—for instance, that one whose meso-element is silicon, we note:—*First*, that the three elements of lower atomic weight than silicon, viz., sodium, magnesium, and aluminium, are distinctly *electro-positive* in character, while those of higher atomic weight, viz., phosphorus, sulphur, and chlorine, are as distinctly *electro-negative*. Throughout the best-known periods this remarkable sub-

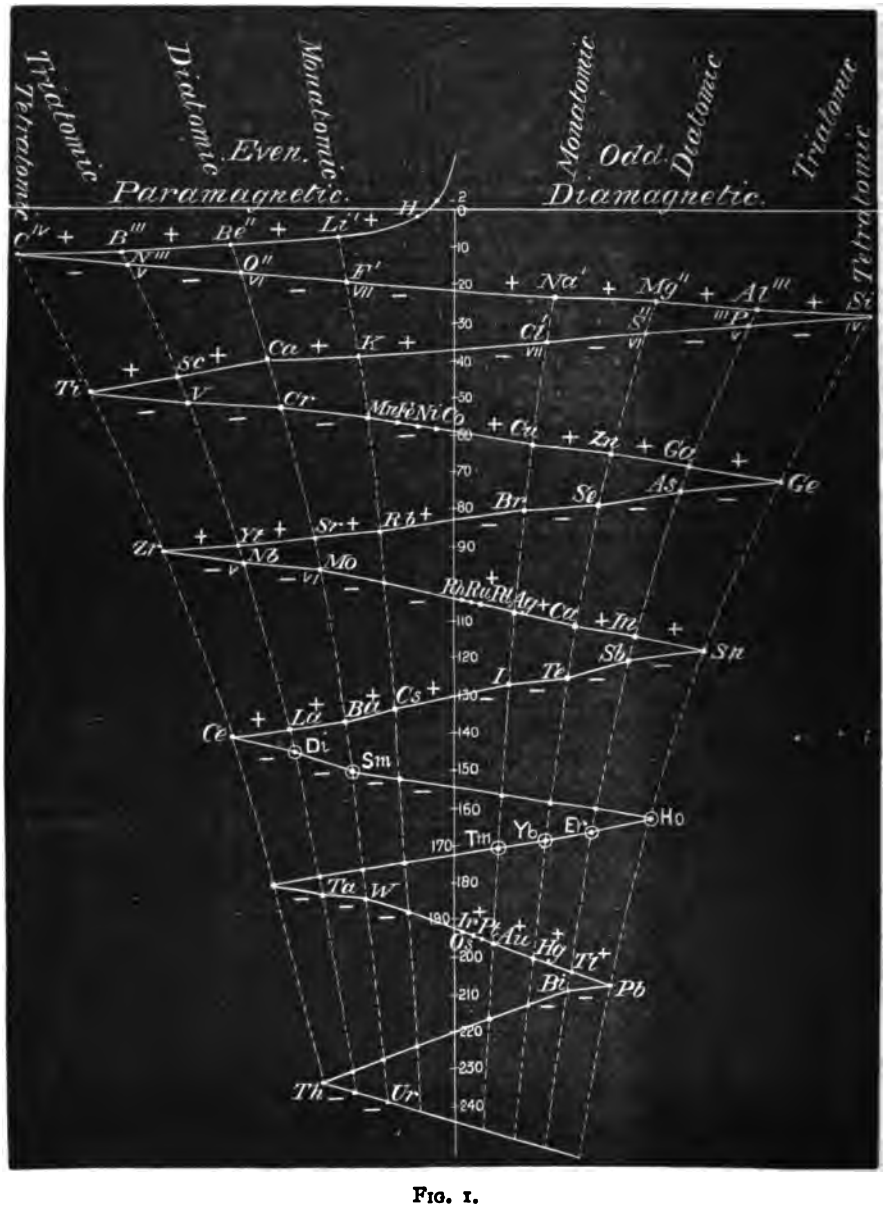

FIG. 1.

there is a change in properties *per saltum*. Further, such alternations of gradual and abrupt transitions are observed as the atomic weights increase. If we thus recognise a contrast in properties—more or less decided—between the first and the last members of each series, we can scarcely help admitting the existence of a point of mean variation within each system. In general, the *fourth* element of each series possesses the properties we might expect a division is observable, although, as might be anticipated, the differences become less strongly marked as the atomic weights increase. *Secondly*, that the members above and below the meso-element fall into pairs of elements, which, while exhibiting certain analogies, are generally in more or less direct chemical contrast. Thus, in the silicon period we have—

Si iv	
+Al‴	P‴–
+Mg″	S″–
+Na′	Cl′–

This division also happens, in many cases, tc coincide with some characteristic valence of the contrasted elements. It is noteworthy, however, that the members on the electro-negative side exhibit the most marked tendency to variation in atom-fixing power, so that valence alone is an untrustworthy guide to the probable position of an element in a period.

Thus for the purpose of graphic translation Professor Reynolds considers that the fourth member of a period—silicon, for example—may be placed at the apex of a symmetrical curve, which shall represent, for that particular period, the direction in which the properties of the series of elements vary with rising atomic weights.

In the drawing before you (Fig. 1) I have modified Prof. Reynolds's diagram in one or two points. I have turned it the reverse way, as it is more convenient to start from the top and proceed downwards.

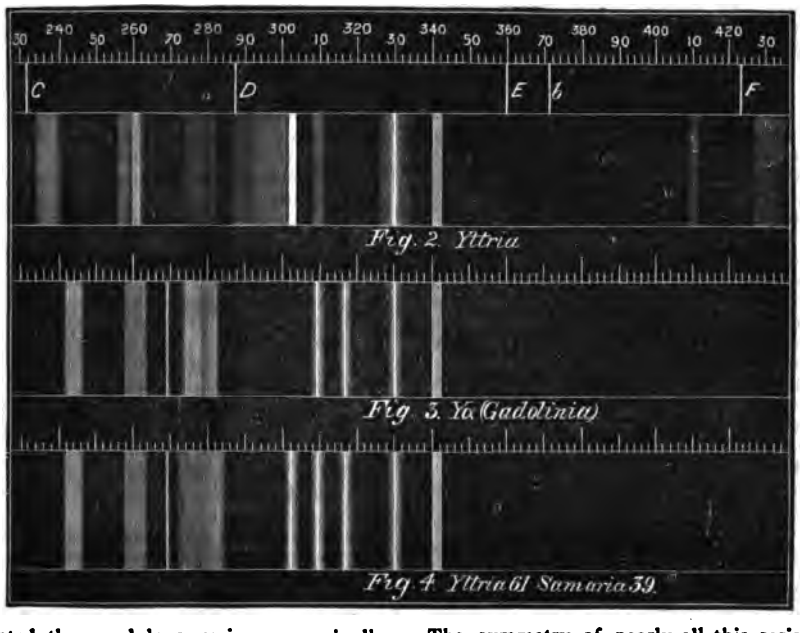

Fig. 2. Yttria

Fig 3. Ya Gadolinia

Fig 4 Yttria 61 Samaria 39

I have represented the pendulous swing as gradually declining in amplitude according to a mathematical law, and I have introduced another half-swing of the pendulum between cerium and lead, which not only renders the oscillations more symmetrical. but brings gold, mercury, thallium, lead, and bismuth on the side where they are in complete harmony with members of foregoing groups, instead of being out of harmony with them. This modification has another advantage, inasmuch as it leaves many gaps to be hereafter filled in with new elements just when the development of research is beginning to demand room for such expansion.

I do not, however, wish to infer that the gaps in Mendeleeff's table, and in this graphic representation of it, necessarily mean that there are elements actually existing to fill up the gaps; these gaps may only mean that at the birth of the elements there was an easy potentiality of the formation of an element which would fit into the place.

Following the curve from hydrogen downwards we find that the elements forming Mendeleeff's eighth group are to be found near three of the ten nodal points. These bodies are "interperiodic," both because their atomic weights exclude them from the small periods into which the other elements fall, and because their chemcal relations with certain members of the adjacent periods show that they are probably interperiodic in the sense of being transitional.

This eighth group is divided into the three triplets—iron, nickel, and cobalt; rhodium, rathenium, and palladium; iridium, osmium, and platinum. The members of each triplet have often been regarded as modifications of one single form of matter.

Notice how accurately the series of like bodies fits into this scheme. Beginning at the top, run the eye down analogous positions in each oscillation, taking either the electro-positive or electro-negative swings:—

N	Be	Li	Na	Mg	Al	Si	P	S	Cl	C
V	Ca	K	Cu	Zn	Ga	Ge	As	Se	Br	Ti
Nb	Sr	Rb	Ag	Cd	In	Sn	Sb	Te	I	Zr
—	Ba	Cs	—	—	—	—	—	—	—	—
Ta			Au	Hg	Tl	Pb	Bi			

Notice, also, how orderly the metals discovered by spectrum analysis fit in their places—gallium, indium, and thallium.

The symmetry of nearly all this series proclaims at once that we are working in the right direction. We can also learn much from the anomalies here visible. Look at the places marked with a circle; didymium, samarium, holmium, erbium, ytterbium, and thulium. Didymium cannot follow in order after the triad nitrogen, vanadium, columbium; nor erbium follow phosphorus, arsenic, antimony; nor thulium follow chlorine, bromine, iodine; nor ytterbium follow potassium, rubidium, cæsium. The inference to be drawn is that these bodies are out of place, owing to their atomic weights not having been correctly determined,—an inference which is strengthened by the knowledge that the elementary character of some of these bodies is more than doubtful, whilst the chemical attributes of most of them are unknown.

The more I study the arrangement of this zigzag curve the more I am convinced that he who grasps the key will be permitted to unlock some of the deepest mysteries of creation. Let us imagine if it is possible to get a glimpse of a few of the secrets here hidden. Let us picture the very beginnings of time, before geological ages, before the earth was thrown off from the central

nucleus of molten fluid, before even the sun himself had consolidated from the original *protyle*.* Let us still imagine that at this primal stage all was in an ultra-gaseous state, at a temperature inconceivably hotter† than anything now existing in the visible universe; so high, indeed, that the chemical atoms could not yet have been formed, being still far above their dissociation-point. In so far as *protyle* is capable of radiating or reflecting light, this vast sea of incandescent mist, to an astronomer in a distant star, might have appeared as a nebula, showing in the spectroscope a few isolated lines, forecasts of hydrogen, carbon, and nitrogen spectra.

But in course of time some process akin to cooling, probably internal, reduces the temperature of the cosmic *protyle* to a point at which the first step in granulation takes place; matter as we know it comes into existence, and atoms are formed. As soon as an atom is formed out of *protyle* it is a store of energy, potential (from its tendency to coalesce with other atoms by gravitation or chemically) and kinetic (from its internal motions). To obtain this energy the neighbouring *protyle* must be refrigerated by it,‡ and thereby the subsequent formation of other atoms will be accelerated. But with atomic matter the various forms of energy which require matter to render them evident begin to act; and, amongst others, that form of energy which has for one of its factors what we now call *atomic weight*. Let us assume that the elementary *protyle* contains within itself the potentiality of every possible combining proportion or atomic weight. Let it be granted that the whole of our known elements were not at this epoch simultaneously created. The easiest formed element, the one most nearly allied to the *protyle* in simplicity is first born. Hydrogen,—or shall we say helium?—of all the known elements the one of simplest structure and lowest atomic weight, is the first to come into being. For some time hydrogen would be the only form of matter (as we now know it) in existence, and between hydrogen and the next formed element there would be a considerable gap in time, during the latter part of which the element next in order of simplicity would be slowly approaching its birth-point: pending this period we may suppose that the evolutionary process which soon was to determine the birth of a new element, would also determine its atomic weight, its affinities, and its chemical position.

In the original genesis, the longer the time occupied in that portion of the cooling down during which the hardening of the *protyle* into atoms took place, the more sharply defined would be the resulting elements; and, on the other hand, with more irregularity in the original cooling, we should have a nearer approach to the state of the elemental family such as we know it at present.

In this way it is conceivable that the succession of events which gave us such groups as platinum, osmium, and iridium,—palladium, ruthenium, and rhodium,—iron, nickel and cobalt, if the operation of genesis had been greatly more prolonged, would have resulted in the birth of only one element of these groups. It is also probable that by a much more rapid rate of cooling, elements would originate even more closely related than are nickel and cobalt, and thus we should have formed the nearly allied elements of the cerium, yttrium, and similar groups; in fact the minerals of the class of samarskite and gadolinite may be regarded as the cosmical lumber-room where the elements in a state of arrested development—the unconnected missing links of inorganic Darwinism—are finally aggregated.

I have said that the original *protyle* contained within itself the potentiality of all possible atomic weights. It may well be questioned whether there is an absolute uniformity in the mass of every ultimate atom of the same chemical element. Probably our atomic weights merely represent a mean value around which the actual atomic weights of the atoms vary within certain narrow limits.

Each well-defined element represents a platform of stability connected by ladders of unstable bodies. In the first accreting together of the primitive stuff the smallest atoms would form, then these would join together to form larger groups, the gulf across from one stage to another would be gradually bridged over, and the stable element appropriate to that stage would absorb, as it were, the unstable rungs of the ladder which led up to it. I conceive, therefore, that when we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on. We are here reminded of Newton's "old worn particles."

Is it not possible, or even feasible, that these heavier and lighter atoms may have been in some cases subsequently sorted out by a process resembling chemical fractionation? This sorting out may have taken place in part while atomic matter was condensing from the primal state of intense ignition, but also it may have been partly effected in geological ages by successive solutions and re-precipitations of the various earths.

This may seem an audacious speculation, but I do not think it is beyond the power of chemistry to test its feasibility. An investigation on which I have been occupied for several years has yielded results which to me appear apposite to the question, and I therefore beg permission here to allude briefly to some of the results, reserving details to a subsequent communication to the Section.

My work has been with the earths present in samarskite and gadolinite, separating them by systematic fractionation. Chemical fractionation, on which I hope to say more on another occasion, is very similar to the formation of a spectrum with a wide slit and a succession of shallow prisms. The centre portion remains unchanged for a long time, and the only approach to purity at first is at the two ends, while a considerable series of operations is needed to produce an appreciable change in the centre. The groups of didymium and yttrium earths are those which have chiefly occupied my attention. On comparing these rare earths we are at once struck with the close mutual similarity, verging almost into identity, of the members of the same group.

The phosphorescent spectra of these earths when their anhydrous sulphates are submitted to the induction discharge *in vacuo* are extremely complicated, and change in their details in a puzzling manner. For many years I have been persistently groping on in almost hopeless endeavour to get a clue to the meaning I felt convinced was locked up in these systems of bands and lines. It was impossible to divest myself of the conviction that I was looking at a series of autograph inscriptions from the molecular world, evidently of intense interest, but written in a strange and baffling tongue. All attempts to decipher the mysterious signs were, however, for a long time, fruitless. I required a Rosetta stone.

Down to a date comparatively recent nothing was more firmly fixed in my mind than the notion that yttria was the oxide of a simple body, and that its phosphorescent spectrum gave a definite system of coloured bands,

* We require a word, analogous to protoplasm, to express the idea of the original primal matter existing before the evolution of the chemical elements. The word I have ventured to use for this purpose is compounded of προ (*earlier than*) and ὑλη (*the stuff of which things are made*). The word is scarcely a new coinage, for 600 years ago Roger Bacon wrote in his *De Arte Chymiæ*—"The elements are made out of ὑλη, and every element is converted into the nature of another element."

† I am constrained to use words expressive of high temperature; but I confess I am unable clearly to associate with *protyle* the idea of hot or cold. *Temperature*, *radiation*, and *free cooling* seem to require the periodic motions that take place in the chemical atoms; and the introduction of centres of periodic motion into protyle would constitute its being so far changed into chemical atoms.

‡ I am indebted to my friend G. Johnstone Stoney, F.R.S., for the idea here put forward, as well as for other valuable suggestions and criticisms on some of the theoretical questions here treated of.

such as you see in the drawing before you (Fig. 2). Broadly speaking, there is a deep red band, a red band, a very luminous citron-coloured band, a pair of greenish blue bands, and a blue band. It is true these bands varied slightly in relative intensities and in sharpness with almost every sample of yttria I examined; but the general character of the spectrum remained unchanged, and I had got into the way of looking upon this spectrum as characteristic of yttria: all the bands being visible when the earth was present in quantity, whilst only the strongest band of all—the citron band—was visible when traces, such as millionths, were present. But that the whole system of bands spelled yttria and nothing but yttria I was firmly convinced.

During the later fractionations of the yttria earths, and the continued observations of their spectra, certain suspicions which had troubled me for some time assumed consistent form. The bands which hitherto I had thought belonged to yttria began to vary in intensity among themselves, and continued fractionation increased the differences first observed. Whilst I was in this state of doubt and uncertainty, and only beginning to see my way towards arranging into a consistent whole the facts daily coming to light, help came from an unexpected quarter. M. de Marignac, with whom I had been for some time in correspondence, kindly sent me a small specimen of the earth which he had discovered and provisionally named Yα (now gadolinia). In the radiant-matter tube this earth gave a bright spectrum like the one in the diagram before you (Fig. 3). The spectrum above it (Fig. 2) is that ascribed to yttria. Look at the two. Omitting minor details, Yα is yttria with the chief characteristic band—the citron band—left out, and with the double green band of samaria added to it. Now look at Fig. 4, which represents the spectrum of a mixture of 61 parts of yttria and 39 parts of samaria. It is identical almost to its minutest detail with the spectrum of Yα, with this not unimportant difference—the citron band is as prominent as any other line. Yα consists, therefore, of samaria with the greenish blue of yttria and some of the other yttria bands added to it.

I may aptly call the Yα spectrum my Rosetta stone. It threw a flood of light on all the obscurities and contradictions I had found so plentiful, and showed me that a much wider law than the one I had been working upon was the true law governing the occurrence of these obscure phenomena. For what does the spectrum of Yα show? It proves that what I had hitherto thought was one of the chief bands in the yttria spectrum—the citron band—could be entirely removed, whilst another characteristic group—the double green of yttria—could also be separated from the citron.

It would exceed legitimate limits were I to enter into details respecting the chemical and physical reasons which led me to these definite conclusions. To settle one single point more than 2000 fractionations have been performed.

The meaning of the strongly marked symbolic lines had first to be ascertained. For a long time I had to be content with roughly translating one group of coloured symbols as "yttrium" and another group as "samarium," disregarding the fainter lines, shadows, and wings frequently common to both. Constant practice in the decipherment has now given me fuller insight into what I may call the grammar of these hieroglyphic inscriptions. Every line and shadow of a line, each faint wing attached to a strong band, and every variation in intensity of the shadows and wings among themselves, now has a definite meaning which can be translated into the common symbolism of chemistry.

In a mineral containing the rarer earths, those most widely separated in chemical properties are most easily obtained in a state of comparative purity by simple chemical means. For instance, in separating didymium from lanthanum, or samarium from yttrium, a few simple chemical reactions and a little waste will give these bodies in a state of purity; but when it comes to splitting up yttrium into its components ordinary chemical separation is useless, and fractionation must be pushed to the utmost limit, many thousand operations and enormous waste of material being necessary to effect even a partial separation.

Returning therefore, after this explanatory digression, to the idea of heavy and light atoms, we see how well this hypothesis accords with the new facts here brought to light. From every chemical point of view the stable molecular group, yttrium, behaves as an element. Excessive and systematic fractionation has acted the part of a chemical "sorting Demon," distributing the atoms of yttrium into several groups, with certainly different phosphorescent spectra, and presumably different atomic weights, though all these groups behave alike from the usual chemical point of view. Here, then, is one of the elements the spectrum of which does not emanate equally from all its atoms, but some atoms furnish some, other atoms others, of the lines and bands of the compound spectrum of the element. And as this is the case with one element, it is probably so in a greater or less degree with all. Hence the atoms of this element differ probably in weight, certainly in the internal motions they undergo.

Another important inference which may be drawn from the facts is, that the atoms of which yttrium consists, though differing, do not differ continuously, but *per saltum*. We have evidence of this in the fact that the spectroscopic bands characteristic of each group are distinct from those of the other groups, and do not pass gradually into them. We must accordingly expect, in the present state of science, that this is probably the case with the other elements. And the atoms of a chemical element being known to differ in one respect may differ in other respects, and presumably do somewhat differ in mass.

Restricted by limited time and means, even a partial separation of these atomic groupings is possible to me only with enormous difficulty. Have we any evidence that Nature has effected such a separation? The following facts I think supply this evidence.

The earth yttria occurs in several minerals, all extremely rare. These minerals are of very diverse chemical composition, and occur in localities widely separated geographically. Does the pure yttria (*pure* in respect to every other known element) from these different sources behave differently to the radiant-matter test? To the chemist hitherto the earth yttria has been the same thing and has possessed the same properties whatever its source; but armed with this new power of seeing into the atomic groupings which go to make up yttrium, we find evidence of differentiation between one yttrium and another.

Thus when the samarskite yttrium was formed all the constituent atoms—deep red, red, orange, citron, greenish blue, and blue*—condensed together in fair proportion, the deep red being faintest. In gadolinite yttrium the citron and greenish blue constituents are plentiful, the red is very deficient, the orange is absent, and the others occur in moderate quantities. In the yttrium from xenotime the citron is most plentiful, the greenish blue occurs in smaller proportion, the red is all but absent, and the orange is quite absent. Yttrium from monazite contains the greenish blue and citron, with a fair proportion of the other constituents; the greenish blue is plentiful, and the red is good. Yttrium from fluocerite is very similar to that from monazite, but the blue is weaker. Yttrium from hielmite is very rich in citron, has a fair quantity of blue and greenish blue, less of red, no orange, and only a very faint trace of deep red. Yttria from euxenite is almost identical with that from hielmite. Yttria from cerite contains most red and citron, a fair amount of orange, less greenish blue and blue, and only a trace of deep red.

This is unlikely to be an isolated case. The principle

* For brevity I call them by their dominant spectrum band.

is very probably of general application to all the elements. In some, possibly in all elements, the whole spectrum does not emanate from all its atoms, but different spectral rays may come from different atoms, and in the spectrum as we see it all these partial spectra are present together. This being interpreted means that there are definite differences in the internal motions which go on in the several groups of which the atoms of a chemical element consist. For example, we must now be prepared for some such events as that the seven series of bands in the absorption-spectrum of iodine may prove not all to emanate from every molecule, but that some of these molecules emit some of these series, others others, and in the jumble of all these kinds of molecules, to which is given the name "iodine vapour," the whole seven series are contributors.

To me it appears the theory I have here ventured to formulate, taken in conjunction with the diagram in Fig. 1, may aid the scientific imagination to proceed a step or two further in the order of elemental evolution. In the undulating curve may be seen the action of two forces, one acting in the direction of the vertical line, and the other pulsating backwards and forwards like a pendulum. Assume the vertical line to represent temperature slowly sinking through an unknown number of degrees, from the dissociation point of the first-formed element down to the dissociation point of those last shown on the scale. But what form of energy is represented by the oscillating line? Swinging to and fro like a mighty pendulum to points equidistant from a neutral centre; the divergence from neutrality conferring atomicity of one, two, three, and four degrees as the distance from the centre is one, two, three, or four divisions; and the approach to, or retreat from, the neutral line deciding the electro-negative or electro-positive character of the element,—all on the retreating half of the swing being positive and all on the approaching half negative—this oscillating force must be intimately connected with the imponderable matter, essence, or source of energy we call electricity.

Let us examine this a little more closely. Let us start at the moment when the first element came into existence. Before this time matter, as we know it, was not. It is equally impossible to conceive of matter without energy, as of energy without matter; from one point of view the two are convertible terms. Before the birth of atoms all those forms of energy which become evident when matter acts upon matter, could not have existed,—they were locked up in the *protyle* as latent potentialities only. Coincident with the creation of atoms all those attributes and properties which form the means of discriminating one chemical element from another start into existence fully endowed with energy.

The pendulum begins its swing from the electro-positive side; lithium, next to hydrogen in simplicity of atomic weight, is now formed; then glucinum, boron, and carbon. Definite quantities of electricity are bestowed on each element at the moment of birth, on these quantities its atomicity depends,* and the types of monatomic, diatomic, triatomic, and tetratomic elements are fixed. The electro-negative part of the swing now commences; nitrogen appears, and notice how curiously position governs the mean dominant atomicity. Nitrogen occupies the position below boron, a triatomic element, therefore nitrogen is triatomic. But nitrogen also follows carbon, a tetratomic body, and occupies the fifth position counting from the place of origin; how beautifully these opposing tendencies are harmonised by the endowment of nitrogen with at least a double atomicity, and making its atom capable of acting as tri- and pentatomic. With oxygen (di- and hexatomic) and fluorine (mon- and heptatomic) the same law holds, and one-half oscillation of the pendulum is completed. Again passing the neutral line the electro-positive elements sodium (monatomic), magnesium (diatomic), aluminium (triatomic), and silicon (tetratomic) are successively formed, and the first complete oscillation of the pendulum is finished by the birth of the electro-negative elements phosphorus, sulphur, and chlorine; these three—like the corresponding elements formed on the opposite homeward swing—having each at least a double atomicity depending on position.

Let us pause at the end of the first complete vibration and examine the result. We have already formed the elements of water, ammonia, carbonic acid, the atmosphere, plant and animal life, phosphorus for the brain, salt for the sea, clay for the solid earth, two alkalies, an alkaline earth, an earth, together with their carbonates, borates, nitrates, fluorides, chlorides, sulphates, phosphates, and silicates, sufficient for a world and inhabitants not so very different from what we enjoy at the present day. True the human inhabitants would have to live in a state of more than Arcadian simplicity, and the absence of calcic phosphate would be awkward as far as bone is concerned. But what a happy world it would be! No silver or gold coinage, no iron for machinery, no platinum for chemists, no copper wire for telegraphy, no zinc for batteries, no mercury for pumps, and, alas! no rare earths to be separated.

The pendulum does not, however, stop at the end of the first complete vibration; it crosses the neutral point, and now the forces at work are in the same position as they were at the beginning. Had everything been as it was at first the next element again would have been lithium, and the original cycle would have recurred, repeating for ever the same elements. But the conditions are not quite the same; the form of energy represented by the vertical line has declined a little,—the temperature has sunk,—and not lithium, but the one next allied to it in the series comes into existence,—potassium, which may be regarded as the lineal descendant of lithium, with the same hereditary tendencies, but with less molecular mobility and higher atomic weight.

Pass we rapidly along the to and fro curve, and in nearly every case the same law is seen to hold good. The last element of the first complete vibration is chlorine. In the corresponding place in the second vibration we do not have an exact repetition of chlorine, but the very similar body bromine; and when for a third time the position recurs we see iodine. I need not multiply examples.

In this far reaching evolutionary scheme it could not come to pass that the potential elements would all be equal to one another. Some would be unable to resist the slightest disturbance of the unstable equilibrium in which they took their rise; others would endure longer, but would ultimately break down as temperature and pressure varied. Many degrees of stability would be here represented; not all the chemical elements are equally stable, and if we look with scrutinising eyes we shall still see our old friend the missing link, coarse enough to be detected by ordinary chemical processes, associated in the groups containing such elements as iron, nickel, and cobalt; palladium, ruthenium, and rhodium; iridium, osmium, and platinum. Whilst in their more subtle form these missing links present themselves as representatives of the differences which I have detected and described between the atoms of the same chemical element.

Dr. Carnelley has pointed out that "those elements belonging to the even series of Mendeleeff's classification are always paramagnetic, whereas the elements belonging

* "Nature presents us with a single definite quantity of electricity .... For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte, which is the same in all cases."—G. Johnstone Stoney, "*On the Physical Units of Nature.*" British Association Meeting, 1874, Section A. *Phil. Mag.*, May, 1881.

"The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion."—Helmholtz, Faraday Lecture, 1881.

"Every monad atom has associated with it a certain definite quantity of electricity; every dyad has twice this quantity associated with it; every triad three times as much, and so on."—O Lodge. —"*On Electrolysis*," "British Association Report," 1885.

to the odd series are always diamagnetic." On this curve the even series to the left, as far as can be ascertained, are paramagnetic, and, with a few exceptions, all to the right are diamagnetic. The very powerful magnetic metals, iron, nickel, cobalt, and manganese, occur close together on the proper side. The interperiodic groups of which palladium and platinum are examples, are said to be feebly magnetic, and if so they form the exceptions. Oxygen, which weight for weight is more magnetic than iron, comes near the beginning of the curve, while the powerfully diamagnetic metals, bismuth and thallium, are at the opposite end of the curve.

On the odd, or diamagnetic half, of the swing, the energy appears to have considerable regularity, whilst it is very irregular on the opposite side of the curve. Thus, between the extreme odd elements, silicon (28), germanium (73), tin (118), the missing element (163), and lead (208), there is a difference of exactly 45 units, conferring remarkable symmetry on one half of the curve. The differences on the even side are 36, 42, 51, 39, and 53 (giving the missing element between cerium and thorium an atomic weight of 180); these at first sight appear conformable to no law, but they become of great interest when it is seen that the mean difference of these figures is almost exactly the same as that on the other side of the curve,—viz., 44·2.

This uniformity of difference,—actual on the one side and average on the other,—brings out the important inference that, whilst on the odd side there has been little or no variation in the vertical force, minor irregularities have been the rule on the even side. That is to say, the fall of temperature has been very uniform on the odd side—where every element formed during this half of the vibration is the representative of a strongly marked group,—sodium, magnesium, aluminium, silicium, phosphorus, sulphur, and chlorine; whilst on the even side of the swing the temperature has sunk with considerable fluctuations, which have prevented the formation here of any well-marked groups of elements, with the exception of those of which lithium and glucinum are the types.

If we can thus trace irregularities in the fall of temperature can we also detect any variation in the force represented by the pendulous movement? I have assumed that this represents chemical energy. In the early formed elements we have those in which chemical energy is at its maximum intensity, while, as we descend, affinities for oxygen are getting less and the chemism is becoming more and more sluggish. Part may be due to the lower temperature of generation not permitting such molecular mobility in the elements, but there can be little doubt that the chemism-forming energy, like the fires of the cosmical furnace, is itself dying out. I have endeavoured to represent this gradual fading out by a diminution of amplitude, the curve being traced from a photographic record of the diminution of the arc of vibration of a body swinging in a resisting medium.

When we look on a curve of this kind there is a tendency to ask, what is there above and below the portion which is seen? At the lower end of our curve what is there to be noted? We see a great hiatus between barium (137) and iridium (192·5), which it seems likely will be filled up by the so-called rare elements. Judging from my own researches, it is probable that many of these earthy elements will be found included in one or more interperiodic groups, whilst the higher members of the calcium, the potassium, the chlorine, and the sulphur groups, together with the elements between silver and gold, cadmium and mercury, indium and thallium, and antimony and bismuth, are still waiting to be discovered. We now come to an oasis in the desert of blanks. Platinum, gold, mercury, thallium, lead, and bismuth, all familiar friends, form a close little group by themselves, and then after another desert space the list is closed with thorium (233) and uranium (240).

This oasis, and the blanks which precede and follow it, may be referred with much probability to the particular way in which our earth developed into a member of our solar system. If this be so it may be that on our earth only these blanks occur, and not generally throughout the universe.

What comes after uranium? I should consider that there is little prospect of the existence of an element much lower than this. Look at the vertical line of temperature slowly sinking from the upper to the lower part of the curve; the figures representing the scale of atomic weights may be also supposed to represent, inversely, the scale of a gigantic pyrometer dipping into the cauldron where suns and worlds are in process of formation. Our thermometer shows us that the heat has been sinking gradually, and, *pari passu*, the elements formed have increased in density and atomic weight. This cannot go on for an indefinite extent. Below the uranium point the temperature may be so reduced that some of the earlier formed elements which have the strongest affinities are able to enter into combination among themselves, and the result of the next fall in temperature will then be—instead of elements lower in the scale than uranium—the combination of oxygen with hydrogen, and the formation of those known compounds the dissociation of which is not beyond the powers of our terrestrial sources of heat.

Let us now turn to the upper portion of the scheme. With hydrogen of atomic weight = 1, there is little room for other elements, save perhaps for hypothetical helium. But what if we get "through the looking-glass," and cross the zero-line in search of new principles,—what shall we find the other side of zero? Dr. Carnelley asks for an element of negative atomic weight; here is ample room and verge enough for a shadow series of such unsubstantialities. Helmholtz says that electricity is probably as atomic as matter*: is electricity one of the negative elements? and the luminiferous ether another? Matter, as we now know it, does not here exist; the forms of energy which are apparent in the motions of matter are as yet only latent possibilities. A substance of negative weight is not inconceivable.† But can we form a clear conception of a body which combines with other bodies in proportions expressible by negative quantities?

A genesis of the elements such as is here sketched out would not be confined to our little solar system, but would probably follow the same general sequence of events in every centre of energy now visible as a star.

Before the birth of atoms to gravitate towards one another, no pressure could be exercised; but at the outskirts of the fire-mist sphere, within which all is protyle,—at the shell on which the tremendous forces involved in the birth of a chemical element exert full sway,—the fierce heat would be accompanied by gravitation sufficient to keep the newly born elements from flying off into space. As temperature increases expansion and molecular motion increase, molecules tend to fly asunder, and their chemical affinities become deadened; but the enormous pressure of the gravitation of the mass of atomic matter outside what I may for brevity call the birth-shell would counteract this action of heat.

Beyond this birth-shell would be a space in which no chemical action could take place, owing to the temperature there being above what is called the dissociation-point for compounds. In this space the lion and the lamb would lie down together; phosphorus and oxygen would mix without union; hydrogen and chlorine would show no tendency to closer bonds; and even fluorine, that energetic gas which chemists have only isolated within the last month or two, would float about free and uncombined.

Outside this space of free atomic matter would be

* "If we accept the hypothesis that the elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity."—HELMHOLTZ, Faraday Lecture, 1881.

† "I can easily conceive that that there are plenty of bodies about us not subject to this intermutual action, and therefore not subject to the law of gravitation."—Sir GEORGE AIRY. "Faraday's Life and Letters," vol. ii., p. 354.

another shell, in which the formed chemical elements would have cooled down to the combination-point, and the sequence of events so graphically described by Mr. Mattieu Williams in "The Fuel of the Sun" would now take place, culminating in the solid earth and the commencement of geological time.

And now I must draw to a close, having exhausted not indeed my subject, but the time I may reasonably occupy. We have glanced at the difficulty of defining an element; we have noticed too the revolt of many leading physicists and chemists against the ordinary acceptation of the term element. We have weighed the improbability of their eternal self-existence, or their origination by chance. As a remaining alternative we have suggested their origin by a process of evolution like that of the heavenly bodies according to Laplace, and the plants and animals of our globe according to Lamarck, Darwin, and Wallace. In the general array of the elements, as known to us, we have seen a striking approximation to that of the organic world. In lack of direct evidence of the decomposition of any element, we have sought and found indirect evidence. We have taken into consideration the light thrown on this subject by Prout's law, and by the researches of Mr. Lockyer in solar spectroscopy. We have reviewed the very important evidence drawn from the distribution and collocation of the elements in the crust of our earth. We have studied Dr. Carnelley's weighty argument in favour of the compound nature of the so-called elements from their analogy to the compound radicals. We have next glanced at the view of the genesis of the elements; and, lastly, we have reviewed a scheme of their origin suggested by Professor Reynolds's method of illustrating the periodic classification.

Summing up all the above considerations we cannot, indeed, venture to assert positively that our so-called elements have been evolved from one primordial matter; but we may contend that the balance of evidence, I think, fairly weighs in favour of this speculation.

This, then, is the intricate question which I have striven to unfold before you, a question that I especially commend to the young generation of chemists, not only as the most interesting but the most profoundly important in the entire compass of our science.

I say deliberately and advisedly the *most interesting*. The doctrine of Evolution, as you well know, has thrown a new light upon and given a new impetus to every department of biology, leading us, may we not hope, to anticipate a corresponding wakening light in the domain of chemistry?

I would ask investigators not necessarily either to accept or to reject the hypothesis of chemical evolution, but to treat it as a provisional hypothesis; to keep it in view in their researches, to inquire how far it lends itself to the interpretation of the phenomena observed, and to test experimentally every line of thought which points in this direction. Of the difficulties of this investigation none can be more fully aware than myself. I sincerely hope that this my imperfect attempt may lead some minds to enter upon the study of this fundamental chemical question, and to examine closely and in detail what I, as if amidst the clouds and mists of a far distance, have striven to point out.

CORRESPONDENCE.

FUCHSINE.

To the Editor of the Chemical News.

Sir,—From his silence on the point which prompted my first letter, namely, the statement that "fuchsine is a name unpronounceable by every Englishman who is not a German scholar," I gather that your Reviewer has retired from his original position as untenable.

He now raises, among other less questionable defences, the objection that fuchsine is an inappropriate name, because fuchsia flowers contain twenty tones of colour which could not be dyed with magenta at all. This argument reminds one of the old riddle about the "cherry-coloured dog." It is true that there are black and white cherries, as well as red cherries; but the terms "cherry-colour," "rose-colour," "violet," &c., are always understood as applying to certain well-known shades. So fuchsine was named from the resemblance of its tint to that of the typical fuchsia flower. I do not say that fuchsine is the best name which can be found for rosaniline salts, and fully share your Reviewer's objection to the coining of a quasi-scientific name for a substance which is not an active or characteristic principle of the plant from which the name originated; but I do contend that fuchsine is a preferable name to magenta, and that the objection raised to it by your Reviewer on the ground of unpronounceability is absolutely without foundation.—I am, &c.,

Alfred H. Allen.

August 25, 1886.

MISCELLANEOUS.

Royal Academy of Arts, Burlington House.—Professor of Chemistry: A. H. Church, M.A.—A course of Lectures on the Chemistry of Paints, of Painting Methods, and of Pictures, will be delivered in November and December, 1886.

The Chemical Laboratory of Wiesbaden.—The Chemical Laboratory at this place still enjoys a very large attendance. Besides the Director, Gen. Hofrath Professor Dr. R. Fresenius, there are engaged as teachers in the establishment Professor Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect Brahm. The assistants in the Laboratory, in the summer term 1886, were fourteen in number, and in the Versuchsstation two. In the summer term 1886 there were eighty students on the books: of these fifty-five are from Germany, five from England, five from Russia, four from France, three from North America, two from Switzerland, two from Sweden, two from Italy, one from Austro-Hungary, and one from Luxemburg. During the last term, besides the scientific researches, a great number of analyses were undertaken in the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, agriculture, and hygiene.

Analysis of Ceylon Soils.—We have received a table of the results of a number of analyses of Ceylon soils from Mr. John Hughes, F.C.S. The samples which were submitted to analysis were selected by the Planters' Association, and represent the soils of a number of the best estates, amongst which are the Ragalla, Dambatenne, Rookwood, Dryburgh, Liddesdale, Pallekelle, &c., on which coffee, tea, cinchona, and cacao have respectively been planted. The samples were all in the air-dried condition, and, on being heated to 212° F., lost water in quantities varying from 4·244 per cent at Dryburgh to 1·218 per cent at Pallekelle. The insoluble silicates and quartz in each case being respectively 55·9 per cent and 79·878 per cent. The highest percentage of organic matter and combined water was found on the Ragalla estate in the Uda Pussellawa district, and amounted to 24·337 per cent. The general results seem to show that cacao will flourish in the poorer soils, the Pallekelle estate, on which this is grown containing only 4·8 per cent of organic matter, 79·8 per cent of quartz and insoluble silicates, and 0·114 per cent of nitrogen, while coffee and cinchona require a higher percentage of organic matter and nitrogen, the highest percentage of the latter being 0·521 per cent.

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Birmingham Meeting, September 1, 1886.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir J. William Dawson, C.M.G., M.A., LL.D., F.R.S., F.G.S., Principal and Vice-Chancellor of McGill University, Montreal, Canada.*

(Concluded from p. 115).

The ocean is a great equaliser of extremes of temperature. It does this by its great capacity for heat and by its cooling and heating power when passing from the solid into the liquid and gaseous states, and the reverse. It also acts by its mobility, its currents serving to convey heat to great distances or to cool the air by the movement of cold icy waters. The land, on the other hand, cools or warms rapidly, and can transmit its influence to a distance only by the winds, and the influence so transmitted is rather in the nature of a disturbing than of an equalising cause. It follows that any change in the distribution of land and water must affect climate, more especially if it changes the character or course of the ocean currents.†

At the present time the North Atlantic presents some very peculiar and in some respects exceptional features, which are most instructive with reference to its past history. The great internal plateau of the American continent is now dry land; the passage across Central America between the Atlantic and Pacific is blocked; the Atlantic opens very widely to the north; the high mass of Greenland towers in its northern part. The effects are that the great equatorial current running across from Africa, and embayed in the Gulf of Mexico, is thrown northward and eastward in the Gulf Stream, acting as a hot-water apparatus to heat up to an exceptional degree the western coast of Europe. On the other hand, the cold Arctic current from the Polar Seas is thrown to the westward, and runs down from Greenland past the American shore.‡ The pilot chart for June of this year shows vast fields of drift ice on the western side of the Atlantic as far south as the latitude of 40°. So far, therefore, the Glacial age in that part of the Atlantic still extends; this at a time when, on the eastern side of the Ocean, the culture of cereals reaches in Norway beyond the Arctic Circle. Let us inquire into some of the details of these phenomena.

The warm water thrown into the North Atlantic not only increases the temperature of its whole waters, but gives an exceptionally mild climate to Western Europe. Still the countervailing influence of the Arctic currents and the Greenland ice is sufficient to permit icebergs which creep down to the mouth of the Strait of Belle Isle, in the latitude of the South of England, to remain unmelted till the snows of a succeeding winter fall upon them. Now let us suppose that a subsidence of land in Tropical America were to allow the equatorial current to pass through into the Pacific. The effect would at once be to reduce the temperature of Norway and Britain to that of Greenland and Labrador at present, while the latter countries would themselves become colder. The northern ice, drifting down into the Atlantic, would not, as now, be melted rapidly by the warm water which it meets in the Gulf Stream. Much larger quantities of it would remain undissolved in summer, and thus an accumulation of permanent ice would take place, along the American coast at first, but probably at length even on the European side. This would still further chill the atmosphere, glaciers would be established on all the mountains of temperate Europe and America,* the summer would be kept cold by melting ice and snow, and at length all Eastern America and Europe might become uninhabitable, except by Arctic animals and plants, as far south as perhaps 40° of north latitude. This would be simply a return of the Glacial age. I have assumed only one geographical change; but other and more complete changes of subsidence and elevation might take place, with effects on climate still more decisive; more especially would this be the case if there were a considerable submergence of the land in temperate latitudes.

We may suppose an opposite case. The high plateau of Greenland might subside or be reduced in height, and the openings of Baffin's Bay and the North Atlantic might be closed. At the same time the interior plain of America might be depressed, so that, as we know to have been the case in the Cretaceous period, the warm waters of the Mexican Gulf would circulate as far north as the basins of the present great American lakes. In these circumstances there would be an immense diminution of the sources of floating ice, and a correspondingly vast increase in the surface of warm water. The effects would be to enable a temperate flora to subsist in Greenland, and to bring all the present temperate regions of Europe and America into a condition of subtropical verdure.

It is only necessary to add that we know that vicissitudes not dissimilar from those above sketched have actually occurred in comparatively recent geological times to enable us to perceive that we can dispense with all other causes of change of climate, though admitting that some of them may have occupied a secondary place.† This will give us, in dealing with the distribution of life, the great advantage of not being tied up to definite astronomical cycles of glaciation, which may not always suit the geological facts, and of correlating elevation and subsidence of the land with changes of climate affecting living beings. It will, however, be necessary, as Wallace well insists, that we shall hold to that degree of fixity of the continents in their position, notwithstanding the submergences and emergences they have experienced, to which I have already adverted. Sir Charles Lyell, more than forty years ago, published in his "Principles of Geology" two imaginary maps which illustrate the extreme effects of various distribution of land and water. In one all the continental masses are grouped around the equator. In the other they are all placed around the poles, leaving an open equatorial ocean. In the one case the whole of the land and its inhabitants would enjoy a perpetual summer, and scarcely any ice could exist in the sea. In the other the whole of the land would be subjected to an Arctic climate, and it would give off immense quantities of ice to cool the ocean. But Lyell did not suppose that any such distribution as that represented in his maps had actually occurred, though this supposition has been sometimes attributed to him. He merely put what he regarded as an extreme case to illustrate what might occur under conditions less exaggerated. Sir Charles, like other thoughtful geologists, was well aware of the general fixity of the areas of the continents, though

* Abstract.

† Von Wœickoff has very strongly put these principles in a Review of Croll's recent book, "Climate and Cosmology"; *American Journal of Science*, March, 1886.

‡ I may refer here to the admirable expositions of these effects by the late Dr. Carpenter, in his papers on the results of the explorations of the *Challenger*.

* According to Bonney the west coast of Wales is about 12° above the average for its latitude, and if reduced to 12° below the average its mountains would have large glaciers.

† More especially the ingenious and elaborate arguments of Croll deserve consideration; and, though I cannot agree with him in his main thesis, I gladly acknowledge the great utility of the work he has done.

with great modifications in the matter of submergence and of land conditions. The union, indeed, of these two great principles of fixity and diversity of the continents lies at the foundation of theoretical geology.

We can now more precisely indicate this than was possible when Lyell produced his "Principles," and can reproduce the conditions of our continents in even the more ancient periods of their history. Some examples may be taken from the history of the American continent, which is more simple in its arrangements than the double continent of Europ-asia. We may select the early Devonian or Erian period, in which the magnificent flora of that age—the earliest certainly known to us—made its appearance. Imagine the whole interior plain of North America submerged, so that the continent is reduced to two strips on the east and west, connected by a belt of Laurentian land on the north. In the great Mediterranean Sea thus produced the tepid water of the equatorial current circulated, and it swarmed with corals, of which we know no less than 150 species, and with other forms of life appropriate to warm seas. On the islands and coasts of this sea was introduced the Erian flora, appearing first in the north, and with that vitality and colonising power of which, as Hooker has well shown, the Scandinavian flora is the best modern type, spreading itself to the south.* A very similar distribution of land and water in the Cretaceous age gave a warm and equable climate in those portions of North America not submerged, and coincided with the appearance of the multitude of broad-leaved trees of modern types introduced in the early and middle Cretaceous, and which prepared the way for the mammalian life of the Eocene. We may take a still later instance from the second continental period of the later Pleistocene or early Modern, when there would seem to have been a partial or entire closure of the North Atlantic against the Arctic ice, and wide extensions seaward of the European and American land, with possibly considerable tracts of land in the vicinity of the Equator, while the Mediterranean and the Gulf of Mexico were deep inland lakes.† The effect of such conditions on the climates of the northern hemisphere must have been prodigious, and their investigation is rendered all the more interesting because it would seem that this continental period of the post-Glacial age was that in which man made his first acquaintance with the coasts of the Atlantic, and possibly made his way across its waters.

We have in America ancient periods of cold as well as of warmth. I have elsewhere referred to the boulder conglomerates of the Huronian, of the Cambrian and Ordovician, of the Millstone-grit period of the Carboniferous and of the early Permian; but would not venture to affirm that either of these periods was comparable in its cold with the later Glacial age, still less with that imaginary age of continental glaciation assumed by certain of the more extreme theorists.‡ These ancient conglomerates were probably produced by floating ice, and this at periods when in areas not very remote temperate floras and faunas could flourish. The glacial periods of our old continent occurred in times when the surface of the submerged land was opened up to the northern currents, drifting over it mud and sand and stones, and rendering nugatory, in so far at least as the bottom of the sea was concerned, the effects of the superficial warm streams. Some of these beds are also peculiar to the eastern margin of the continent, and indicate ice-drift along the Atlantic coast in the same manner as at present, while conditions of greater warmth existed in the interior. Even in the more recent Glacial age, while the mountains were covered with snow and the lowlands submerged under a sea laden with ice, there were interior tracts in somewhat high latitudes of America in which hardy forest trees and herbaceous plants flourished abundantly; and these were by no means exceptional "interglacial" periods. Thus we can show that while from the remote Huronian period to the Tertiary the American land occupied the same position as at present, and while its changes were merely changes of relative level as compared with the sea, these have so influenced the ocean currents as to cause great vicissitudes of climate.

Without entering on any detailed discussion of that last and greatest Glacial period which is best known to us, and is more immediately connected with the early history of man and the modern animals, it may be proper to make a few general statements bearing on the relative importance of sea-borne and land ice in producing those remarkable phenomena attributable to ice action in this period. In considering this question it must be borne in mind that the greater masses of floating ice are produced at the seaward extremities of land glaciers, and that the heavy field-ice of the Arctic regions is not so much a result of the direct freezing of the surface of the sea as of the accumulation of snow precipitated on the frozen surface. In reasoning on the extent of ice action, and especially of glaciers in the Pleistocene age, it is necessary to keep this fully in view. Now in the formation of glaciers at present—and it would seem also in any conceivable former state of the earth—it is necessary that extensive evaporation should conspire with great condensation of water in the solid form. Such conditions exist in mountainous regions sufficiently near to the sea, as in Greenland, Norway, the Alps, and the Himalayas; but they do not exist in low Arctic lands like Siberia or Grinnel-land, nor in inland mountains. It follows that land glaciation has narrow limits, and that we cannot assume the possibility of great confluent or continental glaciers covering the interior of wide tracts of land. No imaginable increase of cold could render this possible, inasmuch as there could not be a sufficient influx of vapour to produce the necessary condensation, and the greater the cold the less would be the evaporation. On the other hand, any increase of heat would be felt more rapidly in the thawing and evaporation of land ice and snow than on the surface of the sea.

Applying these very simple geographical truths to the North Atlantic continents, it is easy to perceive that no amount of refrigeration could produce a continental glacier, because there could not be sufficient evaporation and precipitation to afford the necessary snow in the interior. The case of Greenland is often referred to, but this is the case of a high mass of cold land with sea, mostly open, on both sides of it, giving therefore the conditions most favourable to precipitation of snow. If Greenland were less elevated, or if there were dry plains around it, the case would be quite different, as Nares has well shown by his observations on the summer verdure of Grinnel-land, which, in the immediate vicinity of North Greenland, presents very different conditions as to glaciation and climate.* If the plains were submerged, and the Arctic currents allowed free access to the interior of the continent of America, it is conceivable that the mountainous regions remaining out of water would be covered with snow and ice, and there is the best evidence that this actually occurred in the Glacial period; but with the plains out of water this would be impossible. We see evidence of this at the present day in the fact that in unusually cold winters the great precipitation of snow takes place south of Canada, leaving the north comparatively bare, while as the temperature becomes milder the area of snow-deposit moves farther to the north. Thus a greater extension of the Atlantic, and especially of its cold ice-laden Arctic currents, becomes the most potent cause of a Glacial age.

I have long maintained these conclusions on general

* As I have elsewhere endeavoured to show ("Report on Silurian and Devonian Plants of Canada"), a warm climate in the Arctic region seems to have afforded the necessary conditions for the great colonising floras of all geological periods. Gray had previously illustrated the same fact in the case of the more modern floras.

† Dawkins, *Popular Science Monthly*, 1873.

‡ "Notes on Post-Pliocene of Canada," Hicks, "Pre-Cambrian Glaciers," *Geol. Mag.*, 1880.

* These views have been admirably illustrated by Von Weick... in the paper already referred to, and in previous geographical papers.

geographical grounds, as well as on the evidence afforded by the Pleistocene deposits of Canada; and in an address the theme of which is the ocean I may be excused for continuing to regard the supposed terminal moraines of great continental glaciers as nothing but the southern limit of the ice-drift of a period of submergence. In such a period the southern margin of an ice-laden sea where its floe-ice and bergs grounded, or where its ice was rapidly melted by warmer water, and where consequently its burden of boulders and other *débris* was deposited, would necessarily present the aspect of a moraine, which by the long continuance of such conditions might assume gigantic dimensions. Let it be observed, however, that I fully admit the evidence of the great extension of local glaciers in the Pleistocene age, and especially in the times of partial submergence of the land.

I am quite aware that it has been held by many able American geologists* that in North America a continental glacier extended in temperate latitudes from sea to sea, or at least from the Atlantic to the Rocky Mountains, and that this glacier must, in many places, have exceeded a mile in thickness. The reasons above stated appear, however, sufficient to compel us to seek for some other explanation of the observed facts, however difficult this may at first sight appear. With a depression such as we know to have existed, admitting the Arctic currents along the St. Lawrence Valley, through gaps in the Laurentian watershed, and down the great plains between the Laurentian areas and the Rocky Mountains, we can easily understand the covering of the hills of Eastern Canada and New England with ice and snow, and a similar covering of the mountains of the west coast. The sea also in this case might be ice laden and boulder bearing as far south as 40°, while there might still be low islands far to the north on which vegetation and animals continued to exist. We should thus have the conditions necessary to explain all the anomalies of the glacial deposits. Even the glaciation of high mountains south of the St. Lawrence Valley would then become explicable by the grounding of floe-ice on the tops of these mountains when reefs in the sea. In like manner we can understand how on the isolated trappean hill of Beloeil, in the St. Lawrence Valley, Laurentian boulders far removed from their native seats to the north are perched at a height of about 1200 feet on a narrow peak where no glacier could possibly have left them. The so-called moraine, traceable from the great Missouri Coteau in the west, to the coasts of New Jersey, would thus become the mark of the western and southern limit of the subsidence, or of the line along which the cold currents bearing ice were abruptly cut off by warm surface waters. I am glad to find that these considerations are beginning to have weight with European geologists in their explanation of the glacial drift of the great plains of Northern Europe.

Whatever difficulties may attend such a supposition, they are small compared with those attendant on the belief of a continental glacier, moving without the aid of gravity, and depending for its material on the precipitation taking place on the interior plains of a great continent.

With reference to the transmission of living beings across the Atlantic, we have before us the remarkable fact that from the Cambrian age onwards there were on the two sides of the ocean many species of invertebrate animals which were either identical or so closely allied as to be possibly varietal forms.† In like manner the early plants of the Upper Silurian, Devonian, and Carboniferous present many identical species; but this identity becomes less marked in the vegetation of the more modern times.

In so far as plants are concerned, it is to be observed that the early forests were largely composed of cryptogamous plants, and the spores of these in modern times have proved capable of transmission for great distances. In considering this we cannot fail to conclude that the union of simple cryptogamous fructification with arboreal stems of high complexity, so well illustrated by Dr. Williamson, had a direct relation to the necessity for a rapid and wide distribution of these ancient trees. It seems also certain that some spores, as, for example, those of the Rhizocarps,* a type of vegetation abundant in the Palæozoic, and certain kinds of seeds, as those named *Ætheotesta* and *Pachytheca*, were fitted for flotation. Farther, the periods of Arctic warmth permitted the passage around the northern belt of many temperate species of plants, just as now happens with the Arctic flora; and when these were dispersed by colder periods they marched southward along both sides of the sea on the mountain chains.

The same remark applies to northern forms of marine invertebrates, which are much more widely distributed in longitude than those further south. The late Mr. Gwyn Jeffreys, in one his latest communications to this Association, stated that 54 per cent of the shallow-water mollusks of New England and Canada are also European, and of the deep sea forms 30 out of 35; these last of course enjoying greater facilities for migration than those which have to travel slowly along the shallows of the coasts in order to cross the ocean and settle themselves on both sides. Many of these animals, like the common mussel and sand clam, are old settlers which came over in the Pleistocene period, or even earlier. Others, like the common periwinkle, seem to have been slowly extending themselves in modern times, perhaps even by the agency of man. The older immigrants may possibly have taken advantage of lines of coast now submerged, or of warm periods, when they could creep around by the Arctic shores. Mr. Herbert Carpenter and other naturalists employed on the *Challenger* collections have made similar statements respecting other marine invertebrates, as, for instance, the Echinoderms, of which the deep sea crinoids present many common species, and my own collections prove that many of the shallow water forms are common. Dall and Whiteaves† have shown that some mollusks and Echinoderms are common even to the Atlantic and Pacific coasts of North America; a remarkable fact, testifying at once to the fixity of these species and to the manner in which they have been able to take advantage of geographical changes. Some of the species of whelks common to the Gulf of St. Lawrence and the Pacific are animals which have no special locomotive powers even when young, but they are northern forms not proceeding far south, so that they may have passed through the Arctic seas. In this connection it is well to remark that many species of animals have powers of locomotion in youth which they lose when adult, and that others may have special means of transit. I once found at Gaspé a specimen of the Pacific species of Coronula, or whale barnacle, the *C. reginæ* of Darwin, attached to a whale taken in the Gulf of St. Lawrence, and which had probably succeeded in making that passage around the north of America which so many navigators have essayed in vain.

It is to be remarked here that while many plants and marine invertebrates are common to the two sides of the Atlantic, it is different with land animals and especially vertebrates. I do not know that any fossil insects or land snails or millipedes of Europe and America are specifically identical, and of the numerous species of batrachians of the Carboniferous and reptiles of the Mesozoic all seem to be distinct on the two sides. The same appears to be the case with the Tertiary mammals, until in the later stages of that great period we find such Genera as the horse, the camel, and the elephant appearing on the two

* Report of Mr. Carvill Lewis in "Pennsylvania Geological Survey," 1854; also Dana's "Manual."

† See Davidson's "Monographs on Brachiopods"; Etheridge, "Address to Geological Society of London"; Woodward, "Address to Geologists' Association"; also Barrande's "Special Memoirs on the Brachiopoda, Cephalopoda, &c."; and Hall, "Palæontology of New York"; Billings, "Reports on Canadian Fossils"; and Matthews, "Cambrian of New Brunswick, Trans. R. S. C."

* See paper by the author on Palæozoic Rhizocarps, *Chicago Trans.*, 1886.

† Dall, "Report on Alaska"; Whiteaves, *Trans. R. S. C.*

sides of the Atlantic; but even then the species seem different, except in the case of a few northern forms.

Some of the longer lived mollusks of the Atlantic furnish suggestions which remarkably illustrate the biological aspect of these questions. Our familiar friend the oyster is one of these. The first known oysters appear in the Carboniferous in Belgium and in the United States of America. In the Carboniferous and Permian they are few and small, and they do not culminate till the Cretaceous, in which there are no less than ninety-one so-called species in America alone; but some of the largest known species are found in the Eocene. The oyster, though an inhabitant of shallow water and very limitedly locomotive when young, has survived all the changes since the Carboniferous age, and has spread itself over the whole northern hemisphere.*

I have collected fossil oysters in the Cretaceous clays of the coulées of Western Canada, in the Lias shales of England, in the Eocene and Cretaceous beds of the Alps, of Egypt, of the Red Sea Coast, of Judea, and the heights of Lebanon. Everywhere and in all formations they present forms which are so variable and yet so similar that one might suppose all the so-called species to be mere varieties. Did the oyster originate separately on the two sides of the Atlantic, or did it cross over so promptly that its appearance seems to be identical on the two sides? Are all the oysters of a common ancestry, or did the causes, whatever they were, which introduced the oyster in the Carboniferous act over again in later periods? Who can tell? This is one of the cases where causation and development—the two scientific factors which constitute the basis of what is vaguely called evolution—cannot easily be isolated. I would recommend to those biologists who discuss these questions to addict themselves to the oyster. This familiar mollusk has successfully pursued its course and has overcome all its enemies, from the flat toothed selachians of the Carboniferous to the oyster dredgers of the present day, has varied almost indefinitely, and yet has continued to be an oyster, unless, indeed, it may at certain portions of its career have temporily assumed the disguise of a Gryphæa or an Exogyra. The history of such an animal deserves to be traced with care and much curious information respecting it will be found in the report which I have cited.

But in these respects the oyster is merely an example of many forms. Similar considerations apply to all those Pliocene and Pleistocene mollusks which are found in the raised sea-bottoms of Norway and Scotland, on the top of Moel Tryfaen in Wales, and at similar great heights on the hills of America, many of which can be traced back to early Tertiary times, and can be found to have extended themselves over all the seas of the northern hemisphere. They apply in like manner to the ferns, the conifers, and the angiosperms, many of which we can now follow without even specific change to the Eocene and Cretaceous. They all show that the forms of living things are more stable than the lands and seas in which they live. If we were to adopt some of the modern ideas of evolution we might cut the Gordian knot by supposing that, as like causes can produce like effects, these types of life have originated more than once in geological time, and need not be genetically connected with each other. But while evolutionists repudiate such an application of their doctrine, however natural and rational, it would seem that nature still more strongly repudiates it, and will not allow us to assume more than one origin for one species. Thus the great question of geographical distribution remains in all its force, and, by still another of our geological paradoxes, mountains become ephemeral things in comparison with the delicate herbage which covers them, and seas are in their present extent but of yesterday when compared with the minute and feeble organisms that creep on their sands or swim in their waters.

The question remains, Has the Atlantic achieved its destiny and finished its course, or are there other changes in store for it in the future? The earth's crust is now thicker and stronger than ever before, and its great ribs of crushed and folded rock are more firm and rigid than in any previous period. The stupendous volcanic phenomena manifested in Mesozoic and early Tertiary times along the borders of the Atlantic have apparently died out. These facts are in so far guarantees of permanence. On the other hand, it is known that movements of elevation along with local depression are in progress in the Arctic regions, and a great weight of new sediment is being deposited along the borders of the Atlantic, especially on its western side, and this is not improbably connected with the earthquake shocks and slight movements of depression which have occurred in North America. It is possible that these slow and secular movements may go on uninterruptedly until considerable changes are produced; but it is quite as likely that they may be retarded or reversed.

It is possible, on the other hand, that after the long period of quiescence which has elapsed there may be a new settlement of the ocean-bed, accompanied with foldings of the crust, especially on the western side of the Atlantic, and possibly with renewed volcanic activity on its eastern margin. In either case a long time relatively to our limited human chronology may intervene before the occurrence of any marked change. On the whole the experience of the past would lead us to expect movements and eruptive discharges in the Pacific rather than in the Atlantic area. It is therefore not unlikely that the Atlantic may remain undisturbed, unless secondarily and indirectly, until after the Pacific area shall have attained to a greater degree of quiescence than at present. But this subject is one too much involved in uncertainty to warrant us in following it farther.

In the meantime the Atlantic is to us a practically permanent ocean, varying only in its tides, its currents, and its winds, which science has already reduced to definite laws, so that we can use if we cannot regulate them. It is ours to take advantage of this precious time of quietude, and to extend the blessings of science and of our Christian civilisation from shore to shore until there shall be no more sea, not in the sense of that final drying-up of old ocean to which some physicists look forward, but in the higher sense of its ceasing to be the emblem of unrest and disturbance, and the cause of isolation.

I must now close this address with a short statement of the general objects which I have had in view in directing your attention to the geological development of the Atlantic. We cannot, I think, consider the topics to which I have referred without perceiving that the history of ocean and continent is an example of progressive design, quite as much as that of living beings. Nor can we fail to see that, while in some important directions we have penetrated the great secret of Nature, in reference to the general plan and structure of the earth and its waters, and the changes through which they have passed, we have still very much to learn, and perhaps quite as much to unlearn, and that the future holds out to us and to our successors higher, grander, and clearer conceptions than those to which we have yet attained. The vastness and the might of ocean and the manner in which it cherishes the feeblest and most fragile beings, alike speak to us of Him who holds it in the hollow of His hand, and gave to it of old its boundaries and its laws; but its teaching ascends to a higher tone when we consider its origin and history, and the manner in which it has been made to build up continents and mountain chains, and at the same time to nourish and sustain the teeming life of sea and land.

* White, "Report U.S. Geol. Survey," 1882—83.

Sugary Matter derived from Toluene and Named "Saccharine."—E. Ferrand and L. Rouquès.—The authors put on record the facts that this compound traverses the organism without any alteration, and that is has an antiseptic property. Its sweetness is not at similar to cane-sugar as it has been asserted. Its flavour is slightly saline and raw.—*Journ. de Pharm.*

ON THE METHODS OF CHEMICAL FRACTIONATION.

By WILLIAM CROOKES, F.R.S., V.P.C.S.

It has been suggested that it would interest many present were I to give an account of the chemical operation known as "fractionation." I am the more willing to accede to this suggestion as the reference I made to the method on Thursday last might be considered incomplete without some further description of the process. Broadly speaking the operation consists in fixing upon some chemical reaction in which there is the most likelihood of a difference in the behaviour of the elements under treatment, and performing it in an incomplete manner, so that only a certain fraction of the total bases present is separated: the object being to get part of the material in the insoluble, and the rest in the soluble, state. The operation must take place slowly, so as to allow the affinities—which, by the nature of the case, are almost equally balanced—time to have free play. Let us suppose that two earths are present, almost identical in chemical properties, but differing by an almost imperceptible variation in basicity. Add to the very dilute solution dilute ammonia in such amount that it can only precipitate half the bases present. The dilution must be such that a considerable time elapses before the liquid begins to show turbidity, and several hours will have to elapse before the full effect of the ammonia is complete. On filtering we have the earths divided into two parts, and we can easily imagine that now there is a slight difference in the basic value of the two portions of earth; the portion in solution being, by an almost imperceptible amount, more basic than that which the ammonia has precipitated. This minute difference is made to accumulate by a systematic process until it becomes perceptible by a chemical or physical test.

In most methods of fractionation a rough sort of balance of affinities is arrived at before long, beyond which further separation by the same method is difficult. I have long noticed this action when fractionating with ammonia, with oxalic acid and nitric acids, and with formic acid. One valuable point which renders this fact noteworthy is that the balance of affinities revealed by fractionation is not the same with each process. It was in consequence of the experience gained in these different methods of fractionation that in my paper read before the Royal Society, June 10th last (Chemical News, vol. liv., p. 13), after stating that I had not been able to separate didymium into Dr. Auer's two earths, I said "probably didymium will be found to split up in more than one direction according to the method adopted."

The process adopted must vary according to the bodies under treatment. Fractional crystallisation has yielded new results with didymium in the hands of Dr. Auer von Welsbach; and precipitation with formic acid, with ammonia, or with ammonium oxalate, crystallisation of the oxalates from strong nitric acid, and fusing the nitrates and chlorides, have all given me good results.

Working with the samarskite earths, fractional precipitation with oxalic acid separates first erbia, holmia, and thulia, then terbia, and lastly yttria. This is the only method which is applicable for the separation of small quantities of terbia from yttria.

Fusing the nitrates separates ytterbia, erbia, holmia, and thulia from yttria. It is not so applicable when terbia is present, and is most useful in purifying the gadolinite earths. This process is the only one known for separating ytterbia from yttria.

The formic acid process is best for separating terbia, as terbic formate is difficultly soluble in water, the other formates being easily soluble.

Selection must be made of these methods according to the mixture of earths under treatment, changing the method as one earth or the other becomes concentrated on one side or thrown out on the other. Each operation must be repeated very many times before even approximate purity is attained. The operations are more analogous to the separation of members of homologous series of hydrocarbons by fractional distillation, than to the separations in mineral chemistry as ordinarily adopted in the laboratory.

When the balance of affinities, of which I spoke above, seems to be established, and the earths appear in the same proportion in the precipitate and the solution, they are thrown down by ammonia, and the precipitated earths are worked up by some other process so as to alter the ratio between them, when the previous operation can be again employed.

Fractional precipitation by ammonia is the process generally adopted, for although in some cases it is not so powerful as other processes it is more generally applicable. There are three different methods of operating. According to one plan one-third the equivalent quantity of ammonia is added; then, after the precipitate has quite settled, it is filtered, to the filtrate one-third more ammonia is added, and the precipitate is again filtered off. The remainder of the bases present are then fully precipitated. In this way the earths are divided into three parts, which I will designate -1, 0, and $+1$. Each of these lots is then treated as just described, and the thirds are added to the vessel on each side. This plan is rapid in the actual separations, but I think more time is spent in the extra filterings and washings than is saved in the lessened number of operations.

The second plan is one which was proposed by Prof. Stokes, with whom I have frequently discussed the subject of fractionation. I am indebted to him for the following description of his plan:—

Suppose that A and B are the two earths in solution. It seems reasonable to suppose that the tendency at any moment to precipitation is such that the proportion of the number of molecules of A to that of B that go down, is that of $p \times$ No. of molecules of A in solution, to $q \times$ No. of mols. of B in solution, where p and q are constants, the reciprocals of which may be called the affinities of the earths for the acid. The proportion is accordingly supposed to change even during a single precipitation.

The separation is best when the ratio of the number of molecules left in solution to the whole number is—

$$\frac{qx+py}{x+y}\left(\frac{p^p}{q^q}\right)^{1+(q-p)}$$

where x and y are the numbers of molecules of A and B present in solution before precipitation.

When p and q are very nearly equal — *i.e.*, the earths have nearly the same affinity for the acid—this ratio becomes $\frac{1}{e}$, where e is the base of the Napierian logarithms, 2·718. . . . This is much nearer three than two, indicating that nearly two-thirds of the whole should be precipitated. Prof. Stokes therefore proposes the following plan:—

Suppose the filtrate to travel to the right and the precipitate to the left. Taking the contents of any bottle, precipitate $\frac{2}{3}$rds of the whole, and advance the filtrate 2 places to the right and the precipitate 1 place to the left, and so on. Theoretically this is the best way to operate, and I have carried on several long series with much success by its means. There is, however, a slight disadvantage, in that the precipitate is twice as much as the earth in solution; and as the largest part of the operation is the feeding of the filters, I was obliged to fall back on a plan which, although not theoretically so good, makes up for diminished speed by requiring less manipulation.

The third plan is to add half the equivalent amount of precipitant to the liquid, and, after full settlement, filter. Starting with, say, 1000 grms. in the zero bottle, trans-

* Read before the British Association, Birmingham Meeting, Section B.

fer 500 to bottle −1 and 500 to bottle +1. Then add another 1000 grms to the 0 bottle, and repeat the operations as in the following table:—

NUMBERS OF THE BOTTLES.

	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6
							1000						
A.						500	1000	500					
B.					250	500	500	500	250				
C.				125	250	375	500	375	250	125			
D.			63	125	250	375	375	375	250	125	63		
E.		31	63	156	250	312	375	312	250	156	63	31	
F.	15	31	94	156	234	312	312	312	234	156	94	31	15

After the seventh fractionation the 2000 grms. of earth are spread out amongst 13 bottles in the proportions represented in the bottom line.

The separation of *two* earths by either of these plans is comparatively easy. The precipitation by ammonia depends not directly on the affinities of the earths for the acid, but rather on the excess of affinity of the precipitating ammonia. For if the affinities of the two earths are represented by 100 and 101, and that of ammonia by 150, the affinities on which the precipitation depends would be represented by 150−100=50, and 150−101=49, the difference of which is 2 per cent of the larger.

Now if a precipitant of which the affinity for the acid was only 110 were used, the affinities in question would be 110−100=10, and 110−101=9, and the difference, 10−9=1, is 10 per cent of the larger instead of only 2 per cent. Therefore if an alkali, for which the affinity of the acid was only a little greater than that of the earths, were used for precipitation, it is likely that the differences between the two earths would come out more strongly, and the labour of fractional precipitation might be much reduced. Prof. Stokes has suggested that some of the compound ammonias might prove useful as precipitants instead of ammonia. I have not, however, tested this suggestion.

In Prof. Stokes's method he assumes that as each portion of precipitate falls of its own accord in the same precipitation, the proportion of the earths in the next small portion is that of the quantities remaining in solution multiplied by their respective inverse affinities. If, however, the proportion depends only on the proportions they had when the ammonia was added, but the precipitation had not yet commenced, so that all the flocks which fall one after the other have the same composition, the result will be different. In this case the best result would be obtained by precipitating one-half. When the precipitation is hurried I think the Stokes plan is best, but when the precipitation is so slow that half an hour or more elapses before even a turbidity is apparent in the liquid, I think all the different parts of the precipitate have the same composition, and my plan may be the best.

The values of the two methods, Prof. Stokes's and mine, may be illustrated thus:—In the Stokes method we have two-thirds sent one step to the right and one-third to the left. The value of a step is 0·795, say 0·8. This gives —two-thirds at 0·8, plus one-third at 1·6=1·067. By my method half the quantity is transported one place to the right and half one place to the left. Taking the value of a step as unity the separation is, half at one plus half at one, =1. The result of this estimate is to make the Stokes method about 7 per cent better than mine. As the value of a step in the Stokes process is only about four-fifths of a step in mine, about a fourth more bottles would be required to effect an equal purification. But, on the other hand, the travelling right or left is very distinctly quicker in the Stokes method than in mine. In going right by his plan we take two steps at a bound, though it is true we carry with us only one-third instead of one-half the quantity. In going left we take one step, but then we carry two-thirds instead of only half with us; and in a second operation on this quantity, only one-third, instead of one-half, of that which had come to the left would be carried to the right.

Whichever plan is adopted the amount of earths present has to be determined before each precipitation, so as to know how much ammonia is to be added to get the half or two-thirds precipitated. This is done by standard solutions, and when everything is in good order it does not occupy much time. Filtration is always the lion's share of the trouble.

The above calculations have been based on the assumption that only two earths are present. If more than two are present, either of the above processes fails, in any reasonable time, to yield practically pure specimens of more than two out of a group of closely allied earths. Thus if there are as many as three earths, say A, B, and C, whose positions in reference to the chemical process employed are in the order of sequence in which they are written, we may get a specimen of A as nearly as we please free from B and C, and a specimen of C as nearly as we please free from A and B, but we cannot get a specimen of B practically free from A and C. The law seems to be that *to obtain practically pure specimens of three closely allied earths, it is essential to have recourse to at least two different chemical processes.* The mere continued repetition of the same process will not do, unless indeed the operations are repeated such a vast number of times as to make the approximate expressions no longer applicable, even though the substances are chemically very close.

With a greater number of earths the same law holds good; thus with n earths closely allied, to be separated, we must have recourse to $n-1$ different chemical processes.

I have sometimes adopted the following plan of precipitation:—Having ready standard solutions of acid and ammonia, I add to the neutral solution ammonia sufficient to precipitate nine-tenths of the earths present; after the whole is down I add enough acid to dissolve eight-tenths of the total quantity; then ammonia to precipitate seven-tenths; next acid to dissolve six-tenths, and so on, leaving off when the proportion of precipitate is what is required in the operation. The solutions must be so dilute that no precipation takes place for some time, and the vessels must be well agitated during the whole operation. This makes the separating value of one operation, involving only one filtration, far greater than that of a simple fractional precipitation. The vessels may be of any size, from that of a few gallons to the tubs and tanks used on a manufacturing scale. In a small laboratory such large vessels, however, become unwieldy, and their agitation becomes difficult. Moreover, the rarity of the material makes it unadvisable to use too large vessels, as the unavoidable loss by transference, and the solution in mother-liquors, is greater in large vessels. After long experimentation I have come to the conclusion that common Winchester quart bottles are the best vessels for the precipitations, using several bottles at first for each single precipitation, until the quantity of earths is reduced to within the capacity of one bottle.

The acid in which the earths are dissolved is not a matter of indifference. There is an objection to sulphuric acid on the ground of its disposition to form double salts, so that of the sulphates in solution a good portion might be double sulphates, in which the two molecules of base combined with one of acid consisted one of one base and one of the other; and the two molecules thus intimately associated might tend to remain together, whether as precipitate or as filtrate. On the whole I prefer nitric acid, as having little tendency to form double salts and being easily got rid of.

It is occasionally necessary to completely precipitate the whole contents of the bottles with ammonium oxalate, and after ignition to re-dissolve the earths in acid, and proceed as before. If this precaution is not adopted the accumulation of ammonium nitrate in the solution dissolves an appreciable amount of the earths.

In the ordinary operations of separating distinct esti-

ties, such as the known gadolinite or samarskite earths, it is not difficult, as I have already pointed out, to find different chemical processes, which may be successively employed. When, however, the separations attempted are those of the constituents of yttrium, simple straightforward fractionation, continued steadily month after month and year after year, is the only plan I know.

The operation may be somewhat hastened by removing from the main series certain bottles in which one particular constituent is concentrated, and sub-fractioning these by themselves. Also, to avoid the spreading out sideways to too great an extent, after a certain distance has been proceeded from the centre, say to bottles −20 and +20, the earths are allowed to accumulate in the last bottle at each end. They will after a time be in sufficient amount to sub-fractionate on their own account, and, being at the end of the series, they offer a good chance of getting the two extreme constituents pretty pure.

It will be seen from the above description that there is little hope of success in fractionation unless the supply of crude earths is very large. In my laboratory I have, either worked up or ready for working, over 50 kilos. of samarskite containing about 10 per cent of yttria, and about 20 kilos. of gadolinite containing 48 per cent of yttria, besides a considerable quantity of other rare yttria minerals, giving a total yield of more than 15 kilos. of yttria.

PREPARATION OF IODALDEHYD.

Note on the Reply of M. P. Chautard.

By W. POPPLEWELL BLOXAM and E. F. HERROUN.

M. Chautard has done us the honour of replying to some remarks and questions of ours which appeared in the Chemical News (vol. liii., p. 301) of June last.

We notice that, while M. Chautard repeats his statement that in the preparation of iodaldehyd the reaction is complete in three or four days in summer and eight in the coldest part of the winter, he now informs us that in his experiments the matrass was placed on a staging over a stove where the temperature averaged 30° to 40°, while in his original memoir he distinctly states that the matrass is left at the surrounding temperature. We regret that this misunderstanding as to temperature should have arisen, as, in endeavouring to follow M. Chautard's directions to the letter we did not feel justified in raising the temperature above about 25° at most.

With reference to the question of mass, we gather from M. Chautard's remarks that whilst it is just possible to obtain the iodaldehyd, using only 5 grms. of aldehyd, yet he acknowledges that, working under conditions analogous to those we have employed (viz., those he himself lays down in his original paper), he had much trouble in getting "*any results.*"

We therefore think our criticism of M. Chautard's method as then published was justifiable, and we await with interest the publication which he proposes to make shortly of his modifications and new methods.

We introduced, among others, the quotation from Schoonbroodt to which M. Chautard refers to illustrate the unsatisfactory condition of the present knowledge of the subject rather than to indorse any opinions there expressed, and from our own experience we are quite prepared to believe that the solid product obtained by him was simply a mixture of iodoform and potassic iodide, as M. Chautard now informs us. We are pleased to see that M. Chautard is engaged in elucidating the nature of the decomposition of mon-iodaldehyd by alkalies, yielding iodoform, as it appears to us a point of considerable importance in establishing the position of mon-iodaldehyd among substitution-products.

We further note with interest that M. Chautard has succeeded in obtaining a number of iodo substitution-products of aldehyds of the fatty series. We would take this opportunity of expressing our opinion of the great debt our science will owe to M. Chautard for investigating a subject of so much importance, but obscure and attended by so much experimental difficulty and discomfort.

THE SANITARY VALUE OF THE CHEMICAL ANALYSIS OF POTABLE WATERS.*

By WILLIS G. TUCKER, Ph.D.

(Concluded from p. 102.)

These, then, are the principal methods, and the best at present known for the determination of organic matter in potable water.† It will be seen that no one of them enables us to recognise the real morbific material which water may contain or is able to distinguish with certainty between disease-producing constituents and the less harmful or innocent matter of vegetable origin, or that which has resulted from the conversion of harmful into harmless substances. The English Society of Public Analysts have adopted a scheme of analysis which includes both the permanganate and albumenoid ammonia processes, and this method has been largely followed in this country and adopted by our State Board of Health. I have employed it in quite a large number of cases, and it has frequently happened that waters, which had in all probability caused disease, could not be condemned on the evidence furnished by the analysis alone. Mallet would use "all three of the principal processes," since "each gives a certain amount of information which the others do not afford," and adds that "under circumstances admitting only of the use of simpler means of investigation, the albumenoid ammonia and permanganate processes might be employed together, but in no case should only one of these methods be resorted to, such a course entailing practically the neglect of carbon on the one hand or nitrogen on the other." This opinion is based upon the results of an extended research, and to admit that the determination of carbon and nitrogen—perfectly harmless elements in themselves—affords us our best indications in judging of the purity or impurity of a water is to acknowledge that our best analytical methods are far from satisfactory.

What, then, are the questions which a chemical analysis can answer concerning a water viewed from a hygienic standpoint? It may be answered, first, that all attempts to establish definite standards, so that the points for and against a water can be counted up and a balance struck, have signally failed. For there is no unanimity of opinion as to what degree of importance should be attached to the results obtained, and, if there was, such a numerical expression of their relative importance must of necessity be arbitrary and misleading. A committee of the German Public Health Association reported to this effect at the Dusseldorf Meeting in 1883, and the opinion of this committee accords with that of most sanitarians who have investigated the subject.

Secondly, it may be said that with the various means at present at our command, waters which are very pure, chemically, of medium purity, and foul, may be distinguished, but whether these waters are therefore safe to use, doubtful, or harmful, must be a matter of opinion, and is not to be decided by the analytical results. You may take a few spoonfuls of the dejection of a typhoid fever patient and add them to a barrel of distilled water,

* A Paper read before the Albany Institute.

† The scope and limits of this paper do not admit of a consideration of certain recently proposed analytical processes like the "actinic method," in which silver salts in solution are reduced by organic matter when exposed to sunlight, nor of indirect methods of analysis like the determination of the gaseous constituents to which reference has been made.

and a chemical analysis will tell us that the water is pure, and you may add a pound of healthy fœcal matter to another barrel of distilled water, and an analysis will show that it is defiled; yet the first water may, if drunk, give rise to typhoid fever, and the second to no harmful results at all. The analysis of water is like that of air. It can show us the relative amounts of the main and gross constituents, but the organised and living material which may be present, and if so is probably most instrumental in producing disease, can be neither recognised as such nor measured. In the appendix to the report of the Medical Officer of the Local Government Board of Great Britain for 1881, is a report by Dr. Cory on the chemical examination of certain samples of water purposely polluted with excrements from enteric fever patients and other matters. Dr. Buchanan sums up the result of the inquiry by saying: "While we must ever be on the watch for the indications that chemistry affords of contaminating matters gaining access to our waters, we must (at any rate until other methods of recognition are discovered) go beyond the laboratory for evidence of any drinking water being free from dangerous organic pollution. Unless the chemist is well acquainted with the origin and liabilities of the water he is examining he is not justified in speakig of a water as "safe" or "wholesome" if it contains any trace of organic matter whatever; hardly, indeed, even if it contains absolutely none of such matter appreciable by his very delicate methods. The chemist can, indeed, tell us of impurity and hazard, but not of purity and safety. For information about these we must go, with what the chemist has been able to teach us, in search of the conditions surrounding water sources and affecting water services."

We are not, therefore, to infer that water analysis is useless because, in the present state of our knowledge, there are many questions which it cannot satisfactorily answer, for an analysis of a water may reveal to us the presence of compounds which have doubtless resulted from the decomposition of animal matter, as, for instance, in showing us that a well is contaminated by leakage from a cess-pool or privy, or that a reservoir, pond, or river is defiled by sewage mater. Now in the first case the pollution of the well may be harmless, but in the event of specific polluting material entering at any time, as it is quite likely to do at some time, such a well may become a centre for spreading disease, and if so its water should not be used at all, and in the other case, if a larger body of water is markedly polluted by sewage, while the certainty of proving unwholesome or producing specific diseases may not be provable, we shall err on the safe side if we refuse to use such water, the chemical evidence being considered, at least, until we can cut off the access of contaminating matter.

And lastly an analysis may assure us that a given water is of such a degree of purity that the probabilities are that it carries with it no harmful matter, but this kind of evidence is always to be received with caution unless the results of the examination are borne out by other evidence which proves that pollution is not probable. Thus, while a chemical analysis alone cannot tell us that a water is absolutely safe or necessarily harmful, it *can* tell us that a water contains those constituents which may reasonably be believed to accompany harmful matter, and if the question be as to the employment of a given water for a city supply, an exhaustive series of analyses made at different points, stages, times, and seasons may reveal to us the degree of pollution, points at which the polluting matter enters, rapidity of its destruction by natural processes, and the conditions of the water under varying circumstances, and also indicate to us the methods to be employed for improving its quality and obtaining it at its best estate. Such series of analyses have been made during late years in our own country by various chemists, and with very satisfactory results. But a single analysis, or a few analyses, may give us little information or be entirely misleading.

Previous reference has been made to the investigations of Professor Mallet, and as no more thorough work has ever been done in this direction, at home or abroad, and as the conclusions arrived at as the result of an exhaustive study of a multitude of facts confirm the opinions just expressed, some of these conclusions from his report are quoted:—

"1. It is not possible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking water by the mere use of any of the processes examined for the estimation of organic matter or its constituents."

"2. I would even go further and say that in judging the sanitary character of a water, not only must such processes be used in conjunction with the investigation of other evidence of a more general sort as to the source and history of the water, but should even be deemed of secondary importance in weighing the reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds."

"3. There are no sound grounds on which to establish such general "standards of purity" as have been proposed, looking to exact amounts of organic carbon or nitrogen, "albumenoid ammonia," oxygen of permanganate consumed, &c., as permissible or not."

"4. Two entirely legitimate directions seem to be open for the useful examination by chemical means of the organic constituents of drinking water, namely:—First, the detection of *very gross* pollution, ... and secondly, the periodical examination of a water-supply, as of a great city, in order that the normal or usual character of the water having been previously ascertained, any suspicious changes which from time to time may occur shall be promptly detected and their cause investigated."

It was proposed only to discuss chemical methods of examination in this paper, and therefore no reference has been made to the microscopical examination of water deposits, or to biological investigations. The former are often of value and from the latter it was at one time thought, and this is still the opinion of many, that almost everything might be learned, and that chemical analysis had had its day, and was destined to be entirely replaced by biological investigations. Whether the results obtained so far have justified this view is certainly an open question. In my opinion they have not. That such investigations should be made in connection with chemical analyses is generally conceded, and doubtless when our knowledge has increased very valuable results may be obtained thereby, for the probable significance of some classes of micro-organisms seems to be established; but as Mallet has pointed out, basing his statement upon work done by Professor H. Newell Martin, of the Johns Hopkins University, Dr. George M. Sternberg, U.S.A., and others, there is the difficulty often presented "either by the sparseness, or more frequently the abundance, of those organisms in fairly estimating their average relation to the mass of water," and "this difficulty is superadded, of course, to the imperfection of our knowledge as to the effects upon human health of some closely allied—even hardly distinguishable—organisms of dangerous and harmless associations, and of perhaps the same organism in different stages of its life-history."

Two other subjects proposed for discussion remain to be briefly considered. And first as regards the dissemination of diseases by drinking water, there is so much evidence to support the view that polluted waters are prolific sources of disease, that to deny such a cause as an important factor in the propagation of many zymotic diseases, is, to say the least, illogical. Countless sporadic cases of typhoid fever, for instance, have been traced to the use of drinking water polluted by the dejections of those suffering with this disease, and many epidemics of typhoid and cholera have been clearly shown to have had a similar origin. I cannot refrain, in this connection, from referring to the history of the cholera epidemics in Glasgow and Manchester during the present century, taking the facts

from the Rivers Pollution Commission Report for 1874. Up to 1859 Glasgow drew its water supply from the Clyde, which was polluted by the drainage of towns higher up the river. After that year a pure supply was obtained from Loch Katrine. The deaths from cholera in 1832 were 2842; in 1849, 3772; in 1854, 3886; and in 1866, 16; Manchester and Salford have a similar history. Up to 1851 they took their water partly from the River Irwell and partly from wells, both sources being much polluted. In 1832 there were 890 deaths from cholera; in 1849, 1115; and after the introduction of pure water in the epidemic of 1854, but 50 cases, and in 1866, 88 cases. It will be observed that, in the general epidemic of 1854, Glasgow, using polluted water from the Clyde, had 3886 deaths from cholera, while Manchester and Salford, with a purer supply, had but 50 deaths. The death rate per thousand per annum of Manchester, previous to the introduction of its present water supply, was 33, while in 1880 it was 24·7. (Usill, "Statistics of the Water Supply of the Principal Cities and Towns of Great Britain and Ireland," 1881). In 1832 there were 1000 deaths from cholera in Exeter, England, but after purer water was supplied from a point two miles higher up the river than before, and above the point at which the sewage of the town entered; when cholera again visited the city, in 1849, there were but 44 cases, and in 1854 hardly a single case occurred. In 1854 the water supplied by the Southwark Company, in London, was polluted by sewage, while that of the Lambeth Company was much purer. These companies had pipes in the same streets, and supplied consumers indiscriminately on both sides of streets. The deaths from cholera among those who used the Southwark water were 130 in 10,000, while they were but 37 in 10,000 among those using the better water of the Lambeth Company, while in 1849, when that company took water from a point lower down the river than the Southwark, the death rate was largest among those using their water.

Dr. John Simon, Chief Medical Officer of the Privy Council and of the Local Government Board of Great Britain, testified as follows before the Rivers Pollution Commission: "It is, I think, a matter of absolute demonstration that in the old epidemics, when the south side of London suffered so dreadfully from cholera the great cause of the immense mortality there was a badness of the water supply then distributed in those districts of London.

In all this nothing has been said about disease germs, for like the chemist's atoms their existence even is not proved, though it seems certain that many diseases are produced by specific poisons, of the nature of which we as yet know little, and that in certain diseases these poisons are contained in the excreta, which may give rise to these same diseases through the use of drinking water to which they have gained access. All filth is not necessarily harmful, a statement which hardly needs proof, but the truth of which is well seen in the case reported by Dr. J. C. McKee, U.S.A., in the *New York Medical Journal* for November 3, 1883, in which water containing large quantities of putrescent animal matter was used for two weeks by a garrison of eighty people, including men, women, and children, without producing any deleterious effects, but if some specific kinds of filth *are* poisonous, then the use of a given water which is liable at any time to become specifically polluted should be abandoned, if possible, in favour of a safer source of supply.

And lastly, as regards the natural purification of polluted waters, while the tendency of all organic matter, animal or vegetable, is toward ultimate death and final destruction by oxidation, it is as yet impossible to say how rapidly such a destruction goes on in many cases. The Rivers Pollution Commission mixed urine with water, in the proportion of one part of urine to 3077 of water, agitated the mixture from time to time, and analysed samples. At the end of the eleventh day the improvement in the water was so inconsiderable that other experiments were made in which a stream of impure water was allowed to flow from one vessel to another, and was thus freely exposed to the air, and as a result of these experiments the commissioners concluded that purification by natural oxidation had been greatly over-rated, and that "there is no river in the united kingdom long enough to secure the oxidation and destruction of any sewage which may be discharged into it even at its source." They also conclude that "rivers which have received sewage, even if that sewage has been purified before its discharge, are not safe sources of potable water." (Rivers Pollution Commissioners' 6th Report, pp. 134-8.) Upon this point Frankland says:—"Twelve years ago there was a general impression amongst chemists and others that polluted water quickly regained its original purity by spontaneous oxidation. The opinion had no foundation in quantitative observations; indeed there was not a single experimented fact to prove it. . . . The impression had gained currency from the improved appearance of a polluted river after a flow of a few miles. . . . Two classes of persons strongly interested in its acceptance were chiefly instrumental in the origination and diffusion of this opinion. These were, first, the polluters of running water, and, secondly, water companies drawing their supplies from below the sewer outfalls of towns." (*Journal Chemical Society*, May and July, 1880.) Such improvement as does take place in running streams probably depends more upon the part played by fresh-water plants and micro-organisms than upon direct chemical oxidation, and of course no accurate conclusions can be reached as to the effect of these varying and little understood agencies. Mere dilution also doubtless accounts for the apparent disappearance of much noxious matter. Professor Wm. Ripley Nichols, in his *Water Supply*, italicises the following statement:—"*The apparent self-purification of running streams is largely due to dilution, and the fact that a river seems to have purified itself at a certain distance below a point where it was certainly polluted, is no guaranty that the water is fit for domestic use.*"

To what extent, therefore, must a polluted water be diluted before it is safe to use, is a question of the greatest interest, but one to which no answer can as yet be given. Nor can we prove that the specific poisons of certain diseases—admitting their existence—may not contain living organisms capable of rapid multiplication, nor can we tell for how long a period or under what conditions these organisms may retain their vitality. In this absence of positive knowledge, but in the light of countless facts which all but prove our suppositions true, we had best err, if err we must, on the safe side, avoiding the use of polluted waters and recognising the fact that although chemical analysis may detect no impurities in a water, it is not, therefore, necessarily safe to drink.

The views here presented may seem extreme to those who have long believed on insufficient grounds that from a chemical analysis alone the character of a drinking water may be decided. My endeavour has been to deal with facts, and make no claims for the chemist's ability in this direction which may not be substantiated, and until we have more knowledge than we now possess of the real causes of disease, and until other methods of analytical research shall have been discovered, it is futile to ask the chemist to recognise and measure forms of matter of which he is ignorant, and to state what will be the effect upon the human system of substances the very nature of which is as yet to him unknown.

Gas Engines.—The Government have ordered four 4-horse power "differential" gas engines, Atkinson's patent, with patent air-compressors combined, to work in connection with "Shone's" system of pneumatic drainage, which is being applied to the Houses of Parliament for dealing with the sewage. The engines are to be fixed in the basement under the chambers.

COMMUNICATIONS ON GERMANIUM.

By CLEMENS WINKLER.

For the extraction of germanium argyrodite is smelted with an equal weight of a mixture of equal parts of soda-ash and flowers of sulphur. The solution obtained by lixiviating the melt is mixed with a quantity of sulphuric acid sufficient for neutralisation, whereby sulphur and antimony and arsenic sulphides are precipitated. From the filtrate germanium sulphide is thrown down by the addition of more acid and washed with dilute acid containing hydrogen sulphide. On heating the sulphide with strong nitric acid or driving off the sulphuric acid from the washed sulphide germanium oxide is obtained and may be reduced at a red heat in a current of hydrogen. For the reduction of large quantities it is preferable to knead up the oxide with 10 to 15 per cent of starch and boiling water and ignite moderately in a covered crucible. Germanium is thus obtained as a dark-grey powder. It melts to a very fluid regulus under a layer of borax glass, its melting-point being about 900°. It has a great tendency to regular crystallisation. It is very brittle, easily pulverised, and has a distinct conchoidal fracture. Germanium has a fine metallic lustre, a greyish white colour, and its sp. gr. is 5·469. It is not soluble in hydrochloric acid, but readily in *aqua regia*. Nitric acid converts it into a white oxide, and, on heating with strong sulphuric acid, SO_2 is given off and a white soluble sulphate is formed. Potassa lye has no action. With nitrates and chlorates it yields deflagrating mixtures. The atomic weight was determined by titrating the chlorine contained in the tetrachloride, according to Volhard's method, and found = 72·32. The value obtained by Lecoq de Boisbaudran by a totally different process is 72·28.

The vapour density of the tetrachloride has been determined by L. F. Nilson and O. Petterson, of Stockholm, as 7·43 at 301·5°, and 7·44 at 739°. G. Kobb, of Stockholm, has studied the spark spectrum of germanium. He found as particularly distinct and capable of measurement a line in the orange, one in the yellow, four in the violet, and twelve in the green and the blue.

The compounds of germanium certainly known are two oxides, two sulphides, two chlorides, and one iodide. Many germanium compounds are distinguished by their solubility and some by their volatility. In the flame of the Bunsen burner they give neither a colour nor a spectral reaction. These solutions are slowly precipitated by various metals which decompose water, especially zinc, free germanium being deposited. Most germanium compounds are readily decomposed at elevated temperatures by reducing agents.

Oxides of Germanium.—Compact germanium retains its lustre in the air, but becomes coated with a thin layer of oxide at a red heat. Pulverulent germanium, obtained by reduction, burns like tinder at a gentle heat. Strong nitric acid also effects its oxidation. Germanious oxide, GeO, is obtained on decomposing the chloride, $GeCl_2$, by means of an alkali. The first product is germanious hydroxide, which, on gently heating in a current of carbonic acid, yields the blackish grey oxide, GeO. It is insoluble in dilute sulphuric acid, but dissolves readily in hydrochloric acid. The solution gives a characteristic reaction and is a powerful reducing agent. It converts chromic acid into chromium sesquioxide, &c., and bleaches litmus instantaneously. It has not been ascertained if germanious oxide is capable of forming oxy-salts.

Germanic oxide (germanious acid?), GeO_2, is formed on burning the element in oxygen, on oxidising by means of nitric acid, or on roasting the sulphides. It is obtained perfectly pure by decomposing the chloride with water. Germanic oxide is a dense white powder, sp. gr. 4·703, perfectly permanent on ignition. At 20° 1 part of the oxide dissolves in 247·1 parts of water, and, at 100°, 95·3 parts. On evaporating the solution microscopic crystals are formed. At a moderate red heat this oxide is reduced to germanium by hydrogen or charcoal. It is sparingly soluble in acids, though oxy-salts appear to exist. Its true character is that of an acid, which is confirmed by its solubility in alkalies.

Germanious sulphide, GeS, is formed by heating germanic sulphide, along with an excess of germanium, in a current of carbonic acid or in a slow current of hydrogen. Close beyond the heated spot there are formed thin tables or plumose crystals, grey by reflected but red or orange by transmitted light. If this sulphide is heated in the air it becomes an oxide. It is readily soluble in potassa-lye. From the solution hydrochloric acid throws down amorphous germanious sulphide as an orange powder, which dissolves to chloride in hot strong hydrochloric acid. Amorphous germanious sulphide (though not the crystalline form) dissolves in ammonium sulphide.

Germanic sulphide, GeS_2, is best obtained by precipitating a solution of the oxide with hydrogen sulphide. The voluminous white precipitate is first washed with dilute acid, saturated with H_2S, the acid is then expelled by means of alcohol, saturated with sulphuretted hydrogen, and the washing is then completed with ether, and the product dried in a vacuum. The sulphide is moderately soluble in water. When dry it undergoes spontaneous decomposition in moist air. It is a sulpho-acid and argyrodite is its natural sulpho-salt. Alkaline sulphides form with it soluble sulpho-salts, which seem to precipitate insoluble sulpho-germaniates from the solutions of the heavy metals.

Chlorides of Germanium.—Compact germanium ignites when heated in chlorine and burns with a bluish-white flame to vapours of the tetrachloride. Germanium in the state of powder ignites spontaneously in chlorine.

Germanious chloride, $GeCl_2$, is obtained by passing hydrochloric gas over powdered germanium. It is a colourless limpid fuming liquid; its vapour turns cork an intense red. The liquid boils at 72°, which leads to the suspicion that we have here not the dichloride, but possibly a compound, $GeHCl_3$, analogous to silicochloroform. The addition of a little water separates from the above compound a dense white precipitate, probably an oxychloride. The hydrochloric solution of germanious chloride is a powerful bleaching and reducing agent.

Germanic chloride, $GeCl_4$, is formed by the direct contact of its elements and is freed from free chlorine by contact with mercury. It is a colourless liquid of sp. gr. 1·887 at 18°. It boils at 86°, does not congeal at −20°, fumes in the air, and is decomposed by water.

The iodide, GeI_4, is obtained by the direct contact of its elements. It is of an orange colour, turning yellow if pulverised; melts at 144° and seems to boil between 350° and 400°. It is very hygroscopic, and on contact with water it is gradually converted into white oxide.

A characteristic reaction for germanium has not yet been discovered. The best means for its recognition is the formation of the white sulphide on the addition of ammonium sulphide to an alkaline solution of germanium, followed by a copious addition of hydrochloric acid. This sulphide is the only form into which germanium can be converted for quantitative determination. As germanium forms sulphides soluble in alkaline sulphides it takes place analytically along with arsenic, antimony, and tin. —*Chemiker Zeitung.*

Inversion of Cane-Sugar by Benzoic Acid and the Oxybenzoic Acids.—M. Koral.—From the author's researches it appears that the results on the affinity of the four acids (benzoic, salicylic, meta-oxybenzoic, and para-oxybenzoic) obtained by Prof. Ostwald by means of their electrolytic conductivity agree with the results obtained by the speed of inversion of cane-sugar, and are thus confirmed.—*Journ. Prakt. Chem.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 7, August 16, 1886.

Mono-substituted Haloid Derivatives of Aceto-nitrile.—Louis Henry.—The author concludes that the proximity of nitrogen and of the halogen bodies in carbon compounds communicates to them special properties. This proximity exerts upon the entire molecule volatilising action. It gives the carbon compounds the power of acting strongly upon the skin and the moist mucous membranes. Lastly, it augments the aptitude of reacting upon positive elements. In this three-fold respect nitrogen plays a part similar to that of oxygen.

Composition of the Waters of Bagnères de Luchon.—Ed. Willm.—A paper of no direct chemical interest. None of the rare elements have been detected in the water.

Journal de Pharmacie et de Chimie. Vol. xiv., No. 3, August 1, 1886.

Action of an Electric Current upon Anhydrous Hydrofluoric Acid.—H. Moissan.—This paper, here inserted among "Travaux Originaux," appeared in the *Comptes Rendus* (vol. cii., p. 1543), and thence in the Chemical News (vol. liv., p. 36).

Researches on Ramie. — E. Fremy. — Already noticed.

The Seeds of Bonduc, and their Active Febrifuge Principle.—E. Heckel and F. Schlagdenhauffen.—These seeds are produced by two Brazilian plants, *Cæsalpinia Bonducella* and *C. Bonduc*. The active principle is non-nitrogenous, and its composition is expressed by the formula $C_{14}H_{15}O_5$.

The Synthesis of an Inactive Terpilenol. — G. Bouchardat and J. Lafont.—Already noticed.

Chemical Composition of Japanese Drops. — M. Hupier.—These drops consist of menithol.

Officinal Cinchona Bark. — G. Vulpius. — From the *Chemiker Zeitung*.

Assay of Cocaine.—Cocaine may be modified by the presence of hygrine and ecgonine. If on treating cocaine hydrochlorate with strong sulphuric acid in the cold, we obtain a perfectly colourless solution, the sample is perfectly pure; if the solution is coloured the above-named alkaloids are present.

Journal für Praktische Chemie. New Series, Vol. xxxiv., Part 2.

Action of Orthotoluidine upon Hydroquinone and Resorcin.—M. Philip.—If hydroquinone is heated with orthotoluidine and calcium chloride, or with orthotoluidine alone, there is formed a mixture, varying according to circumstances, of para-oxyphenyl-orthotolylamine and of diorthotolyl-para-phenylen-diamine. The yield of the former base is from 30 to 50 per cent of the theoretical quantity. The derivatives obtained were the hydrochlorate, the dimethyl-ether, and the formyl-, diacetyl-, and dibenzoyl-compounds. Diorthotolyl-para-phenylen-diamine forms white, shining leaflets, melting at 135°, and distilling undecomposed at 420° in a current of hydrogen. Its sulphuric solution is turned of a characteristic violet-blue colour by nitric acid. The yield of diamine was about 80 per cent of the possible quantity. Of the derivatives of resorcin only meta-oxyphenyl-orthotolylamine was obtained in a state of approximate purity.

Investigations on the Relations of Equilibrium in Aqueous Solutions. Part II.—Existence of Acid Salts and Double Salts in Aqueous Solutions.—Acid sodium tartrate is completely resolved into normal salt and free acid only if infinitely diluted, whilst the solution, as its concentration increases, contains larger and larger quantities of the acid salt. The acid alkaline malates are also decomposed by water, but only in part, as complete decomposition would be effected only in infinite dilution. It is probable that double potassium-sodium tartrate is completely resolved into the two single salts, even in strong aqueous solutions.

Action of Chlorine and Bromine upon Organic Bromides and Iodides.—R. Meyer.—This paper does not admit of useful abstraction.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Birmingham Meeting of the British Association:—

President.—William Crookes, F.R.S.

Vice-Presidents.—Prof. Thomas Carnelley, D.Sc.; Dr. W. H. Perkins, V.-P.C.S; Prof. H. E. Armstrong, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. G. Vernon-Harcourt, LL.D., F.R.S.; Dr. W. J. Russell, F.R.S.; Prof. W. A. Tilden, D.Sc., F.R.S.; Prof. A. W. Williamson, Ph.D., LL.D., F.R.S.

Secretaries.—Prof. P. Phillips Bedson, D.Sc. (Recorder); H. B. Dixon, M.A., F.R.S.; H. Forster Morley, M.A., D.Sc.; W. W. J. Nicol, M.A., D.Sc.; C. J. Woodward, B.Sc.

Committee. — A. H. Allen; C. H. Bothamley; H. B. Brady, F.R.S.; A. M. Chance; Sir John Conroy, M.A.; J. T. Dunn, M.Sc.; H. Emmons; T. Fairley; Alfred E. Fletcher; Prof. W. N. Hartley, F.R.S.; C. W. Heaton; E. H. Horne; Prof. Herbert McLeod, F.R.S.; Prof. R. Meldola, F.R.S.; H. R. Mill, D.Sc.; D. H. Nagel; F. G. Newbolt; Prof. W. Ramsay, Ph.D.; W. Chandler Roberts-Austen, F.R.S.; W. T. Ryland; C. Meymott Tidy, M.D.; W. Thorp; Thomas Turner; George Ward; R. Warington, F.R.S.; W. Marshall Watts, D.Sc.; H. Wiggin, M.P.; Prof. W. C. Williams, B.Sc.; S. Young, D.Sc.

The Papers brought before the Section were as follows:—

President's Address.

Dr. W. J. Russell and W. Lapraik.—Absorption Spectra of Uranium Salts.

Prof. T. Carnelley.—The Air of Dwellings and Schools, and its Relation to Disease.

Alexander Pringle.—On some probable new Elements.

A. L. Stern.—Action of Bromine on Chlorides of Phosphorus.

Rev. A. Irving.—Dissociation and Contact Action.

Dr. Nicol.—Report of Committee on Vapour Pressures and Refractive Indices of Salt Solutions.

Prof. Ramsay.—Report of Committee on certain Physical Constants of Solution.

Discussion on the Nature of Solution, opened by *Prof. Tilden*.

Dr. Nicol.—Water of Crystallisation in Solution.

Dr. Perkin.—On the Magnetic Rotation of Mixtures of Water with some of the Acids of the Fatty Series, with Alcohol, and with Sulphuric Acid; and Observations on Water of Crystallisation.

Prof. Ramsay and Dr. Young. — On the Nature of Liquids.

Profs. Armstrong, Hartley, and Pickering, and Dr Gladstone continued the discussion.

Prof. W. N. Hartley. — On the Fading of Water-Colours.

R. Warington.—Distribution of the Nitrifying Organism in the Soil.

Dr. Tidy.—Action of Drinking Water on Lead.

Prof. Odling.—Micro-Organisms in Drinking Water.

W. A. Shenstone.—Report of the Committee on the Influence of the Silent Discharge of Electricity on Oxygen.

H. B. Dixon, F.R.S.—Preservation of Gases over Mercury.

W. Crookes, F.R.S.—The Methods of Chemical Fractionation.

W. Crookes, F.R.S.—On the Fractionation of Yttria.

H. Robinson. The Colour of the Oxides of Cerium and its Atomic Weight.

Prof. Armstrong.—The Determination of the Constitution of Carbon Compounds from Thermo-Chemical Data.

E. F. Ehrhardt.—On the Relative Stability of the Mono-Hydrochlorides $C_{10}H_{17}Cl$, obtained from Turpentine and Camphene respectively.

Dr. R. F. Ruttan.—Derivatives of Tolidin and the Azotolidin Dyes.

J. W. Wailes.—Treatment of Phosphoric Crude Iron in Open Hearth Furnaces.

W. Hutchinson.—Notes on the Basic Bessemer Process in South Staffordshire.

G. Hatton.—Production of Soft Steel in a New Type of Fixed Converter.

T. Turner.—Influence of Re-melting on the Properties of Cast-Iron.

T. Turner.—Silicon in Cast-Iron.

T. Turner.—Influence of Silicon on the Properties of Iron and Steel.

T. Turner.—Estimation of Carbon in Iron and Steel.

Prof. Armstrong.—Report of Committee on Isomeric Naphthalene Compounds.

Dr. W. M. Watts.—Report of the Committee on Wave Lengths.

Dr. H. R. Mill.—Chemistry of Estuary Water.

Dr. Gladstone.—The Essential Oils: a Study in Optical Chemistry.

Dr. G. H. Bailey.—An apparatus for maintaining Constant Temperatures up to 500° C.

W. Thomson.—On a New Apparatus for Readily Determining the Calorimetric Value of Fuel or Organic Compounds.

Prof. Odling.—On some Decompositions of Benzoic Acid.

Dr. O. W. Huntington.—The Crystalline Structure of Iron Meteorites.

TO CORRESPONDENTS.

F. V.—Any operative chemist will supply you with apparatus for making oxygen, and any chemical text-book will tell you how to make it.

NOTICE.

The STUDENTS' NUMBER of the CHEMICAL NEWS *will be published on Friday, September 17th. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

Advertisements for this Number should reach the Office not later than Wednesday, the 15th prox.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES, SOUTH KENSINGTON AND JERMYN STREET.

DEAN—PROFESSOR T. H. HUXLEY, F.R.S.

Session 1886-87.

From the 1st October, 1886, till about the end of June, 1887, the Laboratories will be open to Students in the following Sciences:—

CHEMISTRY AND AGRICULTURE.
PHYSICS.
BIOLOGY.
GEOLOGY.
MECHANICS AND MECHANICAL DRAWING.
METALLURGY, MINING, AND ASSAYING.

The following Courses of Lectures will be given during the Session:—4th October, 1886, Mechanics, Professor T. M. Goodeve M.A.; Inorganic Chemistry, Professor Thorpe, F.R.S.; 5th October 1886, Elementary Zoology, G. B. Howes, Esq.; 7th October, 1886, Principles of Agriculture, J. Wrightson, Esq.; 11th October, 1886, Metallurgy, Professor W. C. Roberts-Austen, F.R.S.; 8th November, 1886, Mining, Professor Warington Smyth, F.R.S.; 4th January, 1887, Elementary Botany, Dr. D. H. Scott; 15th February, 1887, Physics, Professor F. Guthrie, F.R.S.; Geology, Professor J. W. Judd, F.R.S.; Advanced Zoology, G. B Howes, Esq.; Advanced Botany, Dr. D. H. Scott; Organic Chemistry, Dr. F. R. Japp. F.R.S.; Mineralogy, F. Rutley, Esq.; 15th June, 1887, Astronomical Physics, J. Norman Lockyer, Esq., F.R.S.

A course of Mine Surveying, conducted by Mr. B. H. Brough, will begin on the 15th February, 1887.

In addition to the above, lectures will be given in the Chemical Division by Drs. Hodgkinson and Percy Frankland; in the Physical Division by Messrs. Boys, Mitchell, Hoffert, and Captain W. de W. Abney, R.E., F.R.S.

For further particulars apply to the Registrar, Normal School of Science, South Kensington.

The LONDON HOSPITAL and MEDICAL COLLEGE, Mile End, E.

The SESSION 1886-87 will commence on Friday, October 1st, 1886: by that date the New College Buildings will be ready for occupation. The very extensive additions that have been made to the School Premises will afford complete provision for the teaching of all branches of Medical Science; the accommodation provided being more than double that which was provided in the Old Buildings. An inaugural ceremony will take place, of which due notice will be given.

FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All Resident and other Hospital Appointments are free, and the holders of all the Resident Appointments are provided with rooms and board entirely free of expense. The Resident Appointments consist of five House Physiciancies, five House Surgeoncies, one Accoucheurship, and one Receiving-room Officer; four Dressers and four Maternity Pupils also reside in the Hospital. Special Classes for the Preliminary Scientific and Intermediate M.B. Examinations of the University of London and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England are held throughout the year. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South-Eastern Railways have stations within a minute's walk of the Hospital and College.

For prospectus and particulars apply, personally or by letter, to

MUNRO SCOTT, Warden.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to ALEXANDER DEMPSTER, of Elland, Yorkhire, for "Improvements in apparatus for distilling ammoniacal liquor for the purpose of producing sulphate of ammonia," dated 8th March, 1886, No. 3220.

NOTICE IS HEREBY GIVEN that the said Alexander Dempster has applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 3rd September, 1886.

Any person intending to oppose the said application must leave particulars (on Form G) of his objections thereto at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 3rd day of September, 1886.

(Signed) J. CLARK HALL,
Deputy Comptroller-General.

Silicates of Soda and Potash in the state of Soluble Glass, or in CONCENTRATED SOLUTION of first quality, suited for the Manufacture of Soap and other purposes, supplied on best terms by W. GOSSAGE and Sons, Soap Works, Widnes, Lancashire

London Agents, COSTE and Co., 19 and 120, Water Lane, Tower Street, E.C., who hold stock ready for delivery.

THE CHEMICAL NEWS.

Vol. LIV. No. 1399.

ADDRESS TO STUDENTS.

Once more our scientific institutions are resuming their activity, and students are considering the important questions what, where, and above all, how they shall study. Those who intend devoting themselves exclusively or mainly to chemical science will find themselves in various respects placed in a more advantageous position than were their predecessors. The number of colleges and schools where chemistry is taught has increased and is still increasing. Even upon the conductors of the old grammar schools the truth is at last slowly dawning that the arts of observation and of drawing right conclusions from our observations are very important points in education, and that these arts can scarcely be acquired without a training in at least one branch of the physical or natural sciences.

But not merely is the study of chemistry more widely introduced in schools and colleges than heretofore. It is taught by abler men and in laboratories much better fitted with the needful appliances. Here we must guard against a common error. We are often told of the simplicity of the apparatus with which Davy, Dalton, and Graham made important experiments and arrived at valuable results. But this is precisely analogous to what we observe in gold seeking. When a gold field has been recently discovered the digger may secure a rich store of treasure with very simple appliances. But by and by the nuggets are all extracted, and to obtain further supplies of the precious metal it is necessary to mine for auriferous reef, to grind it, and to extract the gold by amalgamation. For these purposes powerful and costly plant is needed.

Now, a precisely similar change is come over chemistry. The phenomena which, so to speak, lay near the surface have been already observed and put on record. If we wish to go on in the career of discovery we must dig deeper. We must make use of instruments of precision which previous investigators did not require. Hence it is a just subject of congratulation if our laboratories are more adequately equipped than were those of Davy and Dalton.

But whilst we rightfully rejoice over the multiplied and improved facilities for study and research, we must ask ourselves whether the play is becoming more and more worthy of the candle; whether the researches conducted in the present day show a sufficient improvement in quantity and quality, as compared with those carried on in this country in the first half of the present century, or with those engaged in abroad? Are we gaining ground, and, if not, why not? We must remember that in higher education, as in other spheres, "one fundamental error can vitiate centuries of national life." A great country has furnished us with a warning example. That country, more perhaps than any other, has placed the highest value upon mental culture, as the only passport to rank and office; it has covered its vast territory with elementary schools, intermediate schools, and universities, and it has invented and practised for ages competitive examination. And what has been the result? A complete arrest of mental development. As Professor Benedict aptly puts it, in China "learning is ceaseless repetition, its education has become a pitiable mummery, finding its supreme test in an act of memory."

Now it surely behoves us to inquire in how far the picture thus drawn of China is applicable to us. What are we cultivating, the art of origination, or merely that of repetition? Are we learning to *do* things or merely to talk about them? Knowledge is certainly power, but there is knowledge and knowledge. A student, for example, might conceivably know by heart the whole of "Watts's Dictionary of Chemistry," and might have a verbal understanding of the whole. Yet he might be unable to perform the simplest analysis, or to apply his knowledge to any practical purpose, much less conduct any experimental research. Now we are not at all anxious for an increase in the number of such men. We consider that a man who is able to add to our knowledge by making even the simplest observation is far more truly entitled to the name of chemist, even though his memory were but scantily stocked with chemical facts.

Faraday is known to have declared that he could never understand the meaning of an experiment until he had performed it himself. How, then, are men of merely average intelligence to understand experiments by merely reading about them? The main objects of the true student, in any department of physical and natural science, are how to observe, how to systematically interrogate Nature, and how to draw right conclusions from the phenomena observed. In proportion as he succeeds in so doing he is likely to be efficient either in abstract science or in the arts. In proportion as a system of education fails in instilling these lessons it becomes a road leading to that stagnation of national intelligence into which China has fallen.

Well does Mr. Patrick Geddes say:—"For two distinct tendencies are at work in our modern universities and schools, the dominant one deliberately preferring memory of mere words to observation of facts and reasoning therefrom, which should be supplied by *discipline* in science, and more memory of words to that coordination of hand and eye which is supplied by practice in the arts and substituting verbal test of competitive examination for practical test in life." *Discipline* in science, not memory of science, is the object to be pursued.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

There are two Examinations for Matriculation in each year; one commencing on the second Monday in January, and the other on the third Monday in June. The Examination is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless

they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

Intermediate Examination in Science.

The Intermediate Examination in Science will be held in July, 1887.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Candidates will be examined as follows:—For a Pass *or* for Honours in (1) Inorganic Chemistry, (2) Experimental Physics, (3) Mathematics; and for a Pass only in (4) General Biology. Candidates may also be examined for Honours in Botany and in Zoology.

Every Candidate, on sending in his name for the Examination, must state whether he intends to compete for Honours in any subject or subjects; and if he does so intend, must specify the subject or subjects.

No Candidate will be allowed to take both the Pass and the Honours Papers in the same subject, but every Candidate must take the Pass Papers in those subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in Inorganic Chemistry, Experimental Physics, and Mathematics, may be recommended by the Examiners for a Pass in these subjects respectively, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.

The Examiners will make no report upon the Examination for Honours of a Candidate who has failed in any part of his Pass Examination.

Examination for Honours.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. Examination.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

Doctor of Science.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

The Fee for this Examination is £10.

Every Candidate for the degree of D.Sc. must forward a statement in writing of the special subject within the purview of the Faculty of Science, as set out in the programme of the B.Sc. Examination, upon a knowledge which he rests his qualification for the Doctorate; and with this statement he shall transmit an original printed Dissertation or Thesis (at least six copies) treating scientifically some special department of the subject so named, embodying the result of independent research, or showing evidence of his own work, whether based on the discovery of new facts observed by himself, or of new relations of facts observed by others, or, generally, tending to the advancement of Science. The Dissertation or Thesis shall have been written in view of candidature, or shall have been published within the two academical years immediately preceding. Every candidate may further specify any printed contribution or contributions to the advancement of Science which he has at any time previously published, and every contribution so specified and submitted shall be considered and taken as part of his qualification for the degree. Candidates for the degree of D.Sc. will be expected to be so fully conversant with the branch of Science they profess as to be able, if required, to satisfy any test of their acquirements in that branch that it may be thought expedient to apply.

Preliminary Scientific (M.B.) Examination.*

This Examination takes place twice in each year,—once, for Pass and Honours, commencing on the third Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

No Candidate shall be admitted to this Examination unless he shall have passed the Matriculation Examination, nor unless he have given notice of his intention to the Registrar at least one calendar month before the commencement of the examination.

The Fee for this examination is Five Pounds.

Candidates for the Pass Examination, whether in January or July, will be allowed either to take all the three subjects of the Examination — (*a*) Inorganic Chemistry, (*b*) Experimental Physics, and (*c*) General Biology—at the same Examination, or to take them at two separate Examinations,—that is to say, two subjects at the first Examination for which they may enter, and one subject at the second Examination; or, reversely, one subject at the first Examination, and two at the second.

Candidates at the July Examination who enter for the whole Examination will be examined as follows:—For a Pass *or* for Honours in (*a*) Inorganic Chemistry, (*b*) Experimental Physics; and for a Pass in (*c*) General Biology. Candidates who have entered for the whole Examination may also be examined for Honours in Botany and in Zoology.

Every Candidate, on sending in his name for the July Examination, must state whether he intends to compete for Honours in any subject or subjects; and, if he does so intend, must specify the subject or subjects.

No Candidate will be allowed to take both the Pass and the Honours Papers in the same subject; but every Candidate must take the Pass Papers in those subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in Organic Chemistry or Experimental Physics may be recommended by the examiners for a Pass in these subjects respectively, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.

Examination in Subjects relating to Public Health.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure and Mixed Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. Full particulars may be obtained by forwarding a stamped directed envelope to the Assistant Registrar, Cambridge, or from the *Cambridge University Calendar*.

The following are the Lectures on Chemistry for the ensuing Academical Year: –

Michaelmas Term, 1886.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 12.

Dissociation and Thermal Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 13.

Thermo Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 12.

General Principles (elementary) by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 13.

General Principles (Advanced), by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Elementary Organic Chemistry, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 13.

General Principles (Non-metals) for Natural Science Tripos, by Mr. Heycock, at King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Oct. 13.

Organic Chemistry, by Mr. R. M. Lewis, at Downing College, on Tuesdays, Thursdays, and Saturdays, at 9 a.m. Begin Oct. 12.

Practical Chemistry, by the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, and Sidney Colleges. Daily. Begin Oct. 12.

Lent Term, 1887.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 15.

Spectroscopic Chemistry, by the Professor of Chemistry, on Tuesdays, at 1.30. Begin Jan. 15.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 17.

General Course of Chemistry, by Mr. Main, at St. John's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 17.

General Principles (continued) by Mr. Pattison Muir, at Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 18.

Principles of Chemistry, Elementary (continued), by Mr. Pattison Muir, Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 27.

Methods of Organic Analysis, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Jan. 17.

Chemical Philosophy, by Mr. Heycock, King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 17.

Practical Chemistry, at the University Laboratory, and at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 17.

EASTER TERM, 1887.

Elementary Chemistry, by a Demonstrator, on Mondays Wednesdays, and Fridays, at 12 noon. Begin April 22.

General Course continued, by Mr. Main, at St. John's College, on Mondays, Wednesdays, and Fridays, at 10. Begin April 22.

Elementary Course for first M.B. (continued), including Carbon Compounds, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 22.

Gas Analysis, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 22.

Aromatic Bodies, on Tuesdays, Thursdays, and Saturdays.

Practical Chemistry, at the University Laboratory, at St. John's College, at Caius College, and at Sidney College, daily. Begin April 22.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

Chemical Tutor.—Herbert Jackson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1886-87, are Tuesday, September 28, Tuesday, January 11, and Wednesday, April 20.

NATURAL PHILOSOPHY.

Professor.—W. G. Adams, M.A., F.R.S.

Demonstrator.—H. Tomlinson, B.A.

Assistant Demonstrator and Tutor.—E. F. Herroun.

The following Classes are held for Students preparing for the Science Examinations of the University of London, Indian Civil Service, and other public examinations, and for those who are studying Natural Philosophy as a part of a liberal education, or who intend to devote themselves to Civil, Mechanical, or Electrical Engineering.

Mechanics.—(1) A Course of between Fifty and Sixty Lectures on Elementary Mechanics and Hydrostatics. (2) A more advanced Course of between Eighty and Ninety Lectures on Theoretical and Applied Mechanics.

Experimental Physics.—(3) A Course of between Fifty and Sixty Lectures on Experimental Mechanics, Hydrostatics, Pneumatics, and Heat. (4) A Course of about Thirty Lectures on Heat, Light, and Sound, *or* Electricity and Magnetism in alternate years. (5) A Course of Demonstrations and Practical Work on Heat, Light, Electricity, and Magnetism.

Fees for either Course separately, including one Course of Mechanics, £4 4s. per Term or £10 10s. per annum.

(6) A Course of Practical Laboratory Work for Students preparing for the Preliminary Scientific and Intermediate Scientific Examinations.

Monday and Thursday, 2 to 4 p.m.

Fees:—£3 3s. per Term or £8 8s. per annum.

(7). A Tutorial Class in Experimental Physics for the Preliminary and Intermediate Scientific Examinations.

Tuesday and Friday, 10.15 to 12.15 a.m.

Fees:—£2 2s. per Course.

EVENING CLASSES.

(*a*) A Winter Course of Lectures on Mechanics, Hydrostatics, and Pneumatics on Monday and Thursday Evenings from 6 to 7 p.m. October to March.

(*b*) A Summer Course on same subjects on Thursday evening, 6.30 to 8 p.m. April to June.

(*c*) A Winter Course of Lectures on Experimental Physics on Wednesday Evening, 7 to 8 p.m.

(*d*) A Course of Practical Work in the Laboratory. Thursday Evening from 7 to 9 p.m. October to March.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

Demonstrator.—W. G. McMillan.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of

Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The instruction given to each student is regulated by his special requirements.

Fees:—Lectures only, £3 3s. The laboratory fees are arranged for continuous work and intermittent work, and special arrangements as to attendance may be made with the Professor.

Two courses of lectures will be delivered on Monday evenings by Mr. W. G. McMillan, in which especial attention will be devoted to the requirements for the examination of the City and Guilds of London Institute, viz., a Course on the "Properties of Metals and Alloys and their Uses in the Arts," and a Course on "Fuels, their Uses and Economy." A Practical Metallurgical Class will be held on Friday evenings, at which students may prepare for the examination of the Science and Art Department in Practical Metallurgy.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 4th, and will terminate on Friday, April 1st, 1887, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., Consulting Chemist to the British Dairy Farmers' Association. The Lectures will be given on Friday Evenings at 6 p.m., beginning October 8th, 1886.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—Alex. W. Williamson, Ph.D., LL.D., F.R.S.

Lecturers.—Henry Forster Morley, M.A., D.Sc.; R. T. Plimpton, Ph.D.

Assistants.—E. E. Graves, F.C.S.; S. Rideal, D.Sc., F.C.S.

The Session is divided into three Terms, as follows, all the dates being inclusive:—

First Term, from Wednesday, October 6th, until Saturday, December 18th;

Second Term, from Tuesday, January 11th, 1887, till Tuesday, March 29th;

Third Term, for Lectures, from Tuesday, April 19th, till Saturday, June 18th. Class Examinations occupy about ten days, beginning on Monday, June 20th.

Students, who having entered in October do not intend to present themselves in all three subjects at the July Preliminary Science Examination, should during the first term confine their attention to Chemistry, and take this subject alone at the January Examination.

Students entering in January should take Physics and Biology at the July Examination, and Chemistry at the succeeding January Examination.

The Special Course on the Metals will be given by Mr. Rideal on Monday, Wednesday, and Friday, at 10.

Introductory or Matriculation Course.

Tuesday, Wednesday, Thursday, and Friday, at 11, commencing May 4, 1887. Fee:—£4 4s.

The Course will consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

General Course of Chemistry and Chemical Physics.

First and Second Terms: Inorganic.—The Class meets five times a week: Mondays, Wednesdays, and Fridays, at 11, for Lectures or Examinations; and on Tuesdays and Thursdays, at 9, for Exercises.

Third Term: Elementary Organic.—Lectures or Exercises, Tuesdays, Wednesdays, and Fridays, at 11.

Fee:—For the Course, £7 7s.; Perpetual, £9 9s.; for the First or Second Terms, £3 3s.; for the Third Term, £2 2s.

The subjects treated in the First Term of the Course include those required in Chemistry at the Matriculation Examination of the University of London.

For the Preliminary Scientific Examination Students who take the three subjects for that examination in July attend during the First and Second Terms.

Extra Meetings of the Exercise Class in connection with the General Course will be held in the Third Term for those Students who intend to present themselves for the Preliminary Scientific or Intermediate Science Examination in July.

The Third Term provides instruction in the preparation, composition, and fundamental properties of the most common important organic substances. The subjects dealt with include those required by Candidates for the First Examination under the conjoint scheme. The last three Meetings will be devoted to recapitulation.

Advanced Course of Inorganic Chemistry.

Third Term:—Monday, Wednesday, and Friday at 4.

Fee:—£2 2s.

The Course will consist of about Thirty Lectures, and is intended as a supplement to the General Course. It includes the subjects required for the Honours Papers in the Preliminary Scientific and Intermediate B.Sc. Examinations and the Additional Inorganic Chemistry for the B.Sc.

Organic Chemistry.

Tuesday and Thursday at 11, Saturday at 9, in the First Term; Monday, Wednesday, and Friday, at 9, in the Second Term; and Tuesday and Thursday, at 9, in the Third Term, beginning Wednesday, October 6th. The hour of meeting will be altered should the Class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int. M.B. are, however, recommended to attend this Course during the First and Second Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11 or 10. Each Student will attend twice a week, at the hour allotted to him, on arrangement with the Professor.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary Scientific, Intermediate B.Sc., and Conjoint Scheme Examinations.

Senior Practical Class.

Mondays and Saturdays from 10 to 12 during the Third Term.

Fee:—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Matriculation Course. (*Women.*)

Lectures: Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Second and Third Terms, commencing Wednesday, January 12th.

Fee:—For the Course, including the cost of apparatus and materials, £4 4s.; for the Third Term, £2 12s. 6d.

Inorganic Chemistry. (Women).

Lectures and Practical Work: Wednesday at 3, Thursday at 12, Friday at 11, Saturday at 10, during the First and Second Terms, beginning on Wednesday, October 6th. The time of meeting will be altered to suit the convenience of the Class.

This Class includes the subjects required for the Preliminary Scientific and Intermediate B.Sc. Examinations. An elementary knowledge of Chemistry will be expected from students joining the class. Simple Qualitative Analysis will be practised by the Students.

Fee, including cost of apparatus and materials, £7 7s.; for the Second Term, £4 4s.

Quantitative Analysis.

A Course of Ten Lectures on the newer methods of Quantitative Analysis will be given during the Second Term, on Mondays, at 4. Fee, £1 1s. Some of the more important operations and methods of Quantitative Analysis will be described, including some of the best methods which are of too recent introduction to have found a place in the ordinary text-books.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays, 9 a.m. to 2 p.m., from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London:—Prel. Sci. (M.B.), Intermediate M.B., Intermediate B.Sc., B.Sc., D.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session.

Chemical Technology.

Professor Charles Graham, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and W. J. Scrutton.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1886-87, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s. for the four Courses, £5 5s.

Courses of Lectures will also be delivered on the Chemistry of Brewing (fee, £3 3s.), and on Chemistry in its relation to Engineering and Architecture (fee £2 2s.).

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

Residence for Students.

Students can obtain residence at University Hall, Gordon Square. Particulars can be obtained of the Dean, Dr. H. Forster Morley, on application.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—T. E. Thorpe, Ph.D., B.Sc., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D., F.R.S.

Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.

Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.
	£	£	£	£
Chemistry	3	13	16	16
Physics	5	12	12	12
Biology with Botany	5	12	12	
Geology with Mineralogy ..	4	8	8	8
Mechanics	4	6	8	8
Metallurgy	2	13	15	
Mining	4	6		
Agriculture	4	10		
Astronomy	2			

Mathematics and Mechanical Drawing £3 per term. Geometrical Drawing, £3 per session. Freehand Drawing, £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session in Chemistry, Zoology, and Mechanics. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The College is open to male and female students not under the age of 15 years. The Session begins on Tuesday, September 21st.

The Courses will be as follows.—I. Introductory and Chemistry of the Non-Metals, during Michaelmas Term. II. Chemistry of the Metals and Chemical Theory, during Lent Term. III. Organic Chemistry and Advanced Theoretical Chemistry, during Easter Term.

Course I. will suffice for the requirements of the London University Matriculation and other similar examinations. Candidates for the Intermediate B.Sc. and Preliminary Scientific (M.B.) Examinations will require Course II. as well, and must also take a course of practical instruction in the Chemical Laboratory. Course III. will meet the requirements of Students taking Chemistry in the B.Sc. and other advanced examinations.

In connection with Courses I. and II. there will be Exercise Classes meeting once a week.

The Lectures will be delivered and the Exercise Classes will meet on Tuesdays, Wednesdays, Thursdays, and Fridays at 10 a.m.

Practical Chemistry.—The Laboratory is open to Students daily during the Session from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except Saturdays.

Special courses will be arranged for those Students who intend following Medicine, Pharmacy, Agriculture, Applied Chemistry, or other professions in which a knowledge of technical chemistry is required.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. The Fee for Practical Chemistry, or Practical Physics, is 5s. per Term extra. Any person wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Professor.—C. M. Thompson, M.A., D.Sc., F.C.S.

Demonstrator.—J. W. James, Ph.D., F.C.S.

The Session commences in October and terminates in June, and is divided into three terms.

The Junior Course (delivered during the summer term only) consists of about 55 lectures, and will cover the subjects prescribed for the London University Matriculation examination. Fee, £2 2s.

The Intermediate Course consists of 90 lectures in continuation of the Junior Series, and, together with laboratory practice, will cover the subjects required for the Intermediate Examination in Science and the Prel. Sci. (M.B.) Examination of the University of London. Tuesdays, Thursdays, and Saturdays at 12. Fee £3 3s.

The Senior Course will occupy about two terms, and includes some 90 lectures devoted to Organic Chemistry; Tuesdays, Thursdays, and Saturdays, at 9. Fee, £3 3s.

A course of 30 lectures on Qualitative and Quantitative Analysis and Chemical Calculations, on Wednesdays at 10.

The Laboratory Course may be modified to meet the requirements of individual students wishing to obtain a special knowledge in some branch of manufacturing or industrial chemistry. Hours, 9 to 1 and 2 to 4.30; Saturday, 9 to 1. Fees—Six hours per week, £3 3s. per session; twelve hours, £2 2s. per term; eighteen hours, £3 3s. per term; twenty-four hours, £4 4s. per term.

Evening Lectures.—A course of Lectures will be given on Elementary Chemistry. Courses of lectures on Chemistry and the Iron and Steel Manufacture will also be delivered in certain towns in South Wales in connection with the local lecture scheme.

At the entrance examination in September, and the annual examination in June, several scholarships, &c., are awarded.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.

Lecturer.—Sydney Young, B.Sc.

The session 1886—87 will begin on October 5. Lectures and classes are held every day and evening throughout the Session. In the Chemical Department lectures and classes are given in all branches of theoretical chemistry, and instruction in practical chemistry is given daily in the chemical laboratory. Excursions to some of the mines, manufactories, and chemical works of the neighbourhood are occasionally made. The department of experimental physics includes various courses of lectures arranged progressively, and practical instruction is given in the physical and electrical laboratory. The Department of Engineering

and the Constructive Professions is designed to afford a thorough scientific education to students intending to become engineers, or to enter any of the allied professions, and to supplement the ordinary professional training by systematic technical teaching. This department includes courses specially arranged for students intending to become civil, mechanical, electrical, or mining engineers, surveyors, or architects. Those who attend the mechanical engineering course enter engineering works during the six summer months, and, in accordance with this scheme, various manufacturing engineers in the neighbourhood have consented to receive students of the College into their offices and workshops as articled pupils. Medical education is provided by the Bristol Medical School, which is affiliated to the College. Several Scholarships are tenable at the College.

DAY LECTURES.

Inorganic Chemistry.

Junior, Senior, and Advanced Classes.

The Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given daily at 9 o'clock.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
„ Two Terms ..	13	11	9	7½	5½
„ One Term ..	7	6	5	4	3
„ Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

Photographic Chemistry.

A Course of Lectures will be given by Mr. A. Richardson, Ph.D., on Mondays at 10, which will cover the subject as prescribed for the Technological Examination of the City and Guilds of London Institute; fee, £1 1s. for each term. The Photographic Laboratory is open from 10 to 5 every Wednesday; fee, £3 3s. for each term. A Course of Evening Lectures on the same subject will also be given on Fridays at 7.

EVENING LECTURES.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the general Principles of Chemistry and Chemical Physics and the Chemistry of Non-Metallic Elements. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 15s. for Two Terms; 10s. for One Term.

A Course of Lectures will also be delivered on Monday evenings at 8, on the Chemistry of Every-day Life.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., D.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Friday, October 1st, 1886.

Elementary Course.

Forty Lectures adapted to the requirements of beginners will be given in the Winter and Spring Terms. A Second Course of Twenty Lectures, having reference only to the subjects included in the syllabus of the Matriculation Examination of the University of London, will be given in the Summer Term. Lecture days—Wednesdays and Fridays, at 11.30.

Persons entirely unacquainted with Chemistry are recommended to attend the first of these Courses before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London are advised to attend both these Courses.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Spring and Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 9.30 a.m. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. January to June (Spring and Summer Terms). About fifty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days—Monday, Tuesday, Wednesday, and Thursday, at 9.30 a.m. Fee, £2 2s.

In all these courses the instruction will often take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Threee Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of Twenty Lectures will be given in the Winter Term (October to Christmas), on Tuesday and Friday Afternoons at 2.30, on the Principles and Practice of Metallurgy. Fee, £1 1s. After Christmas a Course of Lectures will be given on Iron and Steel.

Arrangements have been made in the Chemical Laboratory for giving instruction in Practical Metallurgy.

Evening Classes.

A Course of Twenty Lectures on Elementary Chemistry will be given by Dr. Nicol during the Winter and Spring Terms, on Fridays at 8. Fee, 10s.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

BRADFORD TECHNICAL COLLEGE.

Chemistry and Dyeing.—Edmund Knecht, Ph.D.

Assistant.—Charles H. Jessop.

The school year is divided into three terms, and the Session commenced on September 7th and terminates at the end of July.

The course of instruction extends over two years, and embraces Day and Evening Classes and Practical Laboratory work in Chemistry, Dyeing, and Metallurgy.

The tuition fees are arranged for two classes of students, those paying a reduced sum being expected to sit for the Government Science examinations.

Several exhibitions and scholarships are available for students.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Systematic courses of Lectures are given on the various branches of Chemistry in its relation to Agriculture, illustrated by experiments, and by the collections in the College Museum. They comprise the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationships of their leading groups; and, finally, the applications to practical operations of the Chemistry of the atmosphere, of soils and manures, of vegetation and stock feeding, and of the processes and products of the dairy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, feeding stuffs, dairy products, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—Arthur Smithells, B.Sc. Lond., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 4, 1886.

Lecture Courses.

1. General Course on Systematic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £5 5s.

2. Lectures on Laboratory Practice and Chemical Calculations—Monday, at 12.30 during the First and Second Terms. Fee, £1 1s.

3. Chemistry as Applied to Coal Mining—Wednesday, during the First Term, at 5.30 p.m.

4. Organic Chemistry—Tuesday and Thursday at 12.30 p.m., during the Second and Third Terms. Fee £2 12s. 6d.

5. Lectures on Chemical Technology—Will be varied from session to session. During Session 1886-7 a Course of Lectures "On Fuel" will be given on Wednesdays, at 4 p.m., during the Second and Third Terms. Fee £2 2s.

6. A Class on Elementary Chemistry, consisting of about Twenty-five Lessons, on the Non-metals, will be held on Saturdays, at 12.30 p.m. Fee for the Lecture Class, 10s. 6d.

7. Photographic Manipulation—A Course of Ten Lessons will be given on Fridays, from 2 to 5, during the Third Term, with special reference to dry plate processes and silver and platinum printing. Fee, £1.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 7.30 p.m., beginning October 13. Fee, 10s. 6d.

Dyeing Department.

Professor.—J. J. Hummel, F.C.S.

This Course extends over a period of three years, and is intended for those who wish to obtain a full scientific and practical education in the art of dyeing. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

Several valuable Scholarships are at the disposal of the College, viz., the Cavendish, Salt, Akroyd, Brown, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—J. Campbell Brown, D.Sc.

Demonstrators.—C. A. Kohn, B.Sc., Ph.D., S. G. Rawson, B.Sc.

Assistant.—G. E. Harrison.

The new Chemical Laboratories being now open, the system of teaching in this department has been reorganised so as to afford greater facilities for acquiring a practical

acquaintance with Chemistry in its higher branches, and at the same time give Junior Students a thorough training in the elements and principles of the science. All Students are in the first stages taught alike, and as they advance they may select the branch or methods which they prefer, or which are most suited to their requirements. Besides the Chemical Lecture Theatre, seating 230, a smaller class room and a Practical Theatre accommodating 52 Students in Elementary Practical Chemistry and Qualitative Analysis, ample accommodation is provided for about 40 more advanced Students. An elaborately fitted room is provided for Organic work, which will be used temporarily as a Quantitative Laboratory, while organic operations will be carried on in a second organic room containing arrangements for combustions, operations in sealed tubes, and other special operations. Separate rooms are provided for Water Analysis, Gas Analysis, Photometry and Photography, Spectroscopic and Microscopic work. There is a balance Room, a Furnace Room, besides Stores, Service Rooms, Lavatories, and a separate room for ladies. The teaching is aided, especially in the Organic branch of the science, by a Chemical Museum. A dynamo will shortly be provided and will be used for experiments in the reduction of metals and other work employing electricity. The courses are intended to instruct the Student in Chemical Manipulation, Qualitative and Quantitative Analysis, Gas, Water, and other special branches of analysis, Organic Synthesis, Spectroscopy, and in the method of performing Chemical Researches, and making investigations with the view of applying Chemistry to Manufactures, Agriculture, or Hygiene, or to aid in the study of other sciences.

The Session commences October 4th.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two days a week, during the Lent and Summer Terms; and the Practical Chemistry Class. Mathematics, Pure and Applied, Physics or Geology, Engineering Drawing and Design, French or German.

Second Year.—Chemistry — Second Attendance on portions of the Lecture Courses, if necessary; Lectures on Organic Chemistry; Chemical Laboratory, three days per week, and the Practical Organic Class during the Summer Term; Technological Chemistry. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Lectures on Organic Chemistry; Lectures on Chemical Philosophy; Chemical Laboratory, four or five days per week; Technological Chemistry; Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable mannner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be awarded in December on an Examination in subjects which are included in the first two years of the above curriculum. Other Scholarships, Entrance Scholarships, and Free Studentships are also available to Students.

The Laboratory is opened for Students from 10 a.m. to to 5 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, excepting Saturdays, when they close at 1 p.m. The course of instruction is adapted to the requirements of students of Chemistry as a science, and in its applications to chemical and metallurgical industries. The fee for a three years' course of study is eighty-five guineas, or per session of three months ten guineas.

Prospectuses, containing full particulars of the day and evening classes, may be had on application at the College.

UNIVERSITY OF DURHAM.
COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—Saville Shaw.

The Session will commence on September 27th, 1886.

Junior Division: First Year Course.—This Course of Lectures will extend over the three terms of the Session, and is intended to serve as an introduction to the Science. The Lectures will be of an elementary character, and whilst framed to meet the requirements of First Year Students will also be servicable to such as intend pursuing Chemistry in its various applications in the arts and manufactures, as, for instance, Brewing, Metallurgy, the Manufacture of Soda, Soap, Glass, &c. The subjects treated will include an exposition of the Principles of Chemistry, and a description of the preparation and properties of the chief Elementary Substances, both metallic and non-metallic, and their more important native and artificial compounds. The class will meet on Mondays, Wednesdays, and Fridays, at 9.30 a.m., and will commence on Wednesday, October 6th.

Senior Division: Second Year Course.—A Course of about sixty Lectures will be given throughout the Session, the subject of which will be Organic Chemistry, or the Chemistry of the Carbon Compounds. This class will meet on Tuesdays and Thursdays, at 11 a.m., and will commence on Tuesday, October 5th.

Fee, for either Course, five guineas for the Session.

A Special Course will be given on Applied Chemistry, commencing Thursday, October 7th. Fee, £2 2s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes:—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to

satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 18th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, September 27th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Several other valuable Scholarships are available for students.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—(Vacant).

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Lecturer on Technological Chemistry.—Watson Smith, F.C.S., F.I.C.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Julius B. Cohen, Ph.D., and George H. Bailey, D.Sc.

The Session begins on October 5, 1886, and ends on June 24, 1887.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior. Preparatory:—Chemical Laboratory, two days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Physiography). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior* and Senior classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* classes Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third and fourth courses). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 1s. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees for every combination of classes. Special prospectuses may be obtained at the office of the College.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's courses. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

A number of important Exhibitions, &c., are available to students.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecturer on Dyeing.—Mr. R. L. Whiteley, F.C.S.

The Classes of the College are open to students of both sexes above sixteen years of age. In virtue of the affiliation of the College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge for those intending to take degrees at that University. Reference should be made to the College Prospectus for fuller information.

Lecture Courses.—A systematic course of day lectures is delivered on Tuesday and Friday afternoons at 4.30: the non-metals are treated of in the Autumn Term (October 4th to December 18th), the metals in the Spring Term (January 17th to April 2nd), and the carbon compounds in the Summer Term (April 25th to July 9th).

A course of evening lectures runs parallel with the day course, being delivered on Wednesday evenings at 8 o'clock.

A lecture class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For the day lectures, £2 10s. for the session, and one guinea for a term; for evening lectures, 2s. 6d., or 5s. for lectures and classes per term.

There will also be Classes or Lectures on Chemical Philosophy and Calculations, the Chemistry of the Benzene Series and of Coal-Tar, the Chemistry of Dyeing and Bleaching, and the Chemistry of Brewing.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

and in Qualitative and Quantitative Analysis; and students are enabled to work out the applications of Chemistry to Pharmacy, Dyeing, Agriculture, Brewing, and other Manufacturing Processes. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible.

Fees.—For one term, £6; for the session, £15; for day students for six hours weekly 40s., and 5s. extra for each additional hour per week; for evening students 10s. for one evening per week, and 20s. for two evenings per week.

Government Lectures and Classes.—Evening Lectures and Laboratory instruction will be given by the Demonrator of Chemistry to Students who intend to present themselves for Examination by the Government Science and Art Department in May next. Inorganic, organic, and practical chemistry will be taught in the elementary and advanced stages, each of which commences at the beginning of the College Session in October. Fees for each Lecture Course, 2s. 6d.; for each Laboratory Course, 5s. Students joining these classes are expected to become candidates for the Government Examinations in May.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Tuesday, October 5, 1886.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 12s. 6d.

Third Year's Course.—Organic Chemistry, on Wednesday, from 9 to 10, and Saturday, from 10 to 11. Fee, £1 11s. 6d. Chemical Philosophy, on Saturday at 10. Fee, £2 2s.

Analytical Chemistry.—Lecture course by Mr. O'Shea. Thursday, 11 to 12. Sessional fee, £1 11s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £4 10s.; Nine, £6 10s.; Twelve, £8; Eighteen, £11 5s.: Twenty-four, £14; Thirty-two, £17.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-two hours per week):—For one month, £3 3s.; two months, £5 5s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for twelve hours a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Monday, 8 to 9. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, one evening per week, £1 10s.; two, £3; or Lecture Class and Laboratory, on Monday evening, £1 10s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—Andrew Thomson, M.A., B.Sc.

The fourth session of the College will be opened on October 11th, 1886.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians and Royal College of Surgeons, London, and by the Royal College of Surgeons, Edinburgh, and for degrees in Science and Medicine by the University of Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 3 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 19, 1886.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied

Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.
Chief Assistant.—John M'Arthur.
Laboratory Assistants.—Archibald Kling and Frank Lyall.
Junior Assistants.—James Robson and William Cullen.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10.15 to 11.15, commencing on Wednesday, Oct. 27th. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, select chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 1. Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the course of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but Mr. Dittmar makes it a strict rule not to use his students as his private assistants in connection with his own investigations, and to rather discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Of the several duties which the prestige and traditions of this Chair impose upon its occupant, the first and foremost is to offer to young men, of even limited means, the opportunity of receiving a training in chemistry sufficient to prepare them fully for positions in chemical works, or as professional chemists.

A special Practical Class for Medical Students, meeting twice a week for two hours each time, is conducted during the Summer Session. Fee, including all expenses, £2 2s.

The Evening Department opens on the 2nd of October.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.
Assistant.—Mr. C. Ellis.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 1st. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology. Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. This Course is more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry. Fee for the Course, Two Guineas.

Evening Courses.—There will be a special evening course of twenty-five lectures on Oils, Paints, and Varnishes, commencing on October 18th..

There will be Practical Evening Classes in the following subjects:—Oils, Paints, and Varnishes; Bleaching, Dyeing, and Printing; Iron and Steel; Water Supply and Sewage.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

COLLEGE OF SCIENCE AND ARTS, GLASGOW.

Professor of Chemistry —A. Humboldt Sexton, F.C.S.

During the Session 1886-87 the following Courses of Lectures will be delivered:—

(1.) *Junior.*—A Course of about thirty Lectures, to be delivered on Tuesdays, at 4 o'clock, commencing October 5th. This Course will be of a very elementary character, and will be suited to the needs of those Students who only require a knowledge of the general principles of the Science. Fee, £1 1s.

(2.) *Senior.*—A Course of about ninety Lectures, to be delivered on Mondays, Wednesdays, and Fridays, at 4 o'clock, commencing on October 4th. This will be as complete a course of Elementary Chemistry as time will permit. About sixty Lectures will be devoted to Inorganic Chemistry and the remainder to the elements of Organic Chemistry. Fee, £2 2s.

(3.) A Course of about thirty Lectures on Metallurgy will be delivered on Tuesdays, at 2 o'clock, commencing October 5th. About ten Lectures will be devoted to a consideration of Fuels and Refractory Materials, and the remainder to the Metallurgy of Iron and Steel.

The Laboratories (which have recently been much enlarged and improved, and which now offer every facility for the study of Practical Chemistry) are open daily (except Saturdays), from 10 to 4. Every Student works independently, so that the special needs of each can be attended to. Special attention is given to the requirements of students who intend to devote themselves to Technical Chemistry as a profession. Fee, £12 for the entire Session (October 4th to May 31st), or £2 per month. As far as space will permit, Students will be allowed to work for shorter hours at proportionate fees.

The evening classes in Chemistry, Metallurgy, and Mineralogy commence on Monday, October 4th.

UNIVERSITY OF ST. ANDREWS.

UNITED COLLEGE OF ST. LEONARD AND ST. SALVATOR.

Professor of Chemistry. — T. Purdie, B.Sc., Ph.D., Assoc. R.S.M.

The Session begins on November 2nd. A Competitive Examination, open to intending Students of Arts or Science, for twenty-five Entrance Bursaries, ranging in value from £39 to £5 each per annum, will be held on Friday and Saturday, October 29th and 30th. Two Degrees in Science are conferred by the University of St. Andrews, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.), the regulations regarding which will be found in the "University Calendar."

Lecture Course.

A Lecture is delivered by the Professor of Chemistry, at 11 o'clock, on five days in the week throughout the Winter Session. The Course commences with the study of a few typical substances, forming an introduction to the discussion of Chemical Theory; the Non-metallic and Metallic Elements, with their chief compounds, are then considered; and the latter part of the Course is devoted to Elementary Organic Chemistry. Three Lectures weekly are of an elementary character, and are intended to be useful to Students of Arts who desire to study Chemistry as a branch of general education, or with the view of teaching it in schools; the remaining two Lectures weekly constitute a Supplementary Course, framed so as to meet the additional requirements of Candidates for the Degree of Bachelor of Science and of Medical Students.

Certificates are awarded on the results of separate examinations on the subjects of the general and supplementary Lectures..

Fee for the Session, £3 3s.

Laboratory Course.

A class in Practical Chemistry meets for two hours weekly, to which Students attending the Lectures are admitted without additional fee. The Course consists of a series of qualitative and quantitative experiments, designed to give the Student a practical acquaintance with the principles of Chemistry regarded as a subject of general education.

The Laboratory is also open during the Session from 10 a.m. to 4 p.m., for instruction in Chemical Analysis. The fee is £5 5s. for the Session.

Several free places in the Laboratory will be given to Students desirous of engaging in original work. Applicants must satisfy the Professor that their studies are sufficiently advanced to admit of them prosecuting experimental research.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 19th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and at 3 p.m. after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 19th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

UNIVERSITY OF DUBLIN.

TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D. F.R.S.

Demonstrators. — Augustus E. Dixon, M.D., F.C.S.; William Early, F.I.C.; Robert E. Doran, F.C.S.; Charles E. Moore, A.B.

The general Laboratories now include working accommodation for 100 Students, and the Quantitative and Research Laboratories for about 40 Students. It is expected that the new Lecture Hall will be completed before the Courses of Lectures commence, on November 1st.

The Laboratories and the Lectures of the Professor of Chemistry can now be attended by Students who do not desire to reside in the University or proceed to its Degrees.

The full Course of General and Analytical Chemistry occupies three years, but a Student is free in his third year to devote most of his time to a special department of Pure or Technical Chemistry. Students can enter for any portion of the Course. The following Lectures are delivered:—

1. *Inorganic Chemistry and Chemical Philosophy.*—Elementary, first year; advanced, second year.
2. *Organic Chemistry.* — General, second year; advanced, third year.
3. *Metallurgy.*—A Course for Engineering and Technical Students.

The Laboratories are open every day from 10 to 5 o'clock (except Saturdays, when they close at 1 o'clock).

The Summer Course of Practical Chemistry for Medical Students begins during the first week in April and terminates with the first week in July.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,

STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 4, 1886.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given

n the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each. with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education.—*Central Institution, Exhibition Road.*—Professor of Chemistry, H. E. Armstrong, Ph.D., F.R.S. This Institution is intended to afford such practical, scientific, and artistic instruction as shall qualify persons to become—(1) Technical teachers; (2) Mechanical, civil, and electrical engineers, architects, builders, and decorative artists; (3) Principals, superintendents, and managers of chemical and other manufacturing works. Prominent among the agencies adopted is a scheme of Technological Examinations, in connection with which a large number of classes have been instituted in the various manufacturing centres of the kingdom at which practical instruction is given in the application of Science and Art to different industries. The work done in these classes is inspected by the Institute, and, on the results of the annual examinations, certificates and prizes are granted. *Technical College, Finsbury.*—Professor of Chemistry, Raphael Meldola, F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplemental school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superintendent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Tuesday, October 5th, and ends on December 22nd; the Spring term commences on Tuesday, January 18th, and ends on the 6th of April; the Summer term commences on the 26th of April and ends on July 15th, the evening classes terminating May 27th. An examination for the admission of Students will be held at the College at 10 o'clock on Wednesday, September 29th, 1886, and the work of the Session will commence on Tuesday, October 5th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

City of London College.—Evening Classes in Chemistry, Physics, Electricity, and other Science subjects.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane.—*Organic Chemistry:* A course of 30 Lectures, beginning on October 5th, at 7 p.m., by Mr. H. Chapman Jones, F.C.S. A supplementary Course of about twelve lectures for more advanced students begins in January. Laboratory work and Analysis on Tuesdays, from 6 to 8 p.m. Special facilities are provided for students preparing for the Second B.Sc. (London) Practical Chemistry Examination. *Inorganic Chemistry:* A course of Thirty lectures to Elementary Students, beginning on October 5th, and a course on Chemistry and Analysis to Advanced Students, beginning on October 9th, by Mr. George Chaloner, F.C.S. Classes for Practical Chemistry and Analysis on Tuesday and Saturday evenings, beginning on October 5th.

Crystal Palace Company's School of Art, Science, and Literature. School of Practical Engineering. *Principal*—Mr. J. W. Wilson, Memb. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Friday, the 1st of October. Lectures on Chemistry and Physics, by Prof. Wyndham Dunstan, on Monday, Tuesday, and Wednesdays, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, and Mr. Eastes, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s; for Practical Chemistry, 10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes.*—At the end of each of the five months Courses of Lectures on Chemistry and Physics, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session.

New Central School of Chemistry and Pharmacy, 173, Marylebone Rd., London.—Mr. J. Woodland, F.C.S., M.P.S., and Mr. J. F. Burnett, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

South London School of Pharmacy, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 9 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

South West London Central School of Chemistry and Pharmacy, 183, King's Road, Chelsea.—Special Classes for Students of Medicine. Mr. W. H. Martin.

St. John's Training College, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

Canning Town and Plaistow Science Schools, North Hallsville Board Schools, Canning Town.—Science Classes. Teachers, Mr. C. S. Dawson and Mr. F. R. Holloman.

Royal Victoria Hall, Waterloo Bridge Road, S.E.—Science and Technical Classes, Session 1886-87. Lectures will be given, commencing October 1st (with the exception of Chemistry Course, first Lecture November 3rd), in the following subjects:—Electricity and Magnetism, L. H. Owen, Esq.; Animal Physiology, Dr. Drew, B.Sc.; Inorganic Chemistry, W. Popplewell Bloxam, Esq., F.C.S. Classes are also held in Mathematics, Plane and Solid Geometry, Machine Construction and Drawing, Political Economy and Commercial Arithmetic. The instruction given is suited to artizans and practical men, and is chiefly in connection with the Science and Art Department, South Kensington.

Birmingham.—Queen's College.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

Derby Central School of Science.—Evening Lectures and Practical Laboratory Instruction, commencing September 24. Physics and Mathematics—H. Barfield, D.Sc. Chemistry—Mr. Small, B.Sc.

College of Chemistry, Royal Institution, Hull. Professor, G. Carr Robinson, F.R.S.E., F.I.C., F.C.S. Lectures on Inorganic and Organic Chemistry and on the Manufacture of Oils, Colours, and Varnishes are given during the Winter months. Winter Session begins first week in October.

Institute of Chemical Technology, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus. Fee: Fifty guineas per annum, with extra fee according to circumstances for the special course.

Leeds School of Medicine.—Prof. Smithells.

School of Science of the City and County of Lincoln.—Head-Master and Professor of Chemistry, Dr. A. B. Griffiths, F.R.S. (Edin.) F.C.S., &c. This new School of Chemistry and Science generally will be opened to the public on Monday, September 27th, 1886. The Chemical Laboratory is fitted with every appliance, apparatus, &c., essential for furnishing a well-appointed Laboratory. The Chemical Lecture Theatre is capable of holding 300 Students. Day Lectures on Advanced Inorganic and Organic Chemistry will be given by Dr. Griffiths during the Session. These Lectures will meet the requirements of the B.Sc. (Hon.) and M.B. Examinations of London University, &c. Mr. J. W. Horton, F.R.M.S. (Demonstrator on Chemistry) will give Junior Lecture Courses on Inorganic Chemistry, and also Lectures on Technical Chemistry. There will be Courses of Lectures on Agricultural Chemistry with Laboratory Practice, by Mr. Harris, superintended by Dr. Griffiths. Lectures on the higher Mathematics will be given by the Rev. Chancellor Leeke, M.A. (2nd Wrangler), and the Rev. W. W. Fowler, M.A., F.L.S. Dr. A. B. Griffiths will Lecture on Biology (including Animal Types, Anatomy, Physiology, and Botany). The last two Courses will meet the requirements of London University, Scholarships and Exhibitions at Oxford and Cambridge Universities, &c. Dr. Griffiths will give an opening Lecture on his "Researches in Agricultural Chemistry," on Monday evening, September 27th. Syllabuses containing full particulars may be obtained at the School, or from Dr. Cant, Secretary, Silver Street, Lincoln.

The Technical School, Manchester.—Lecturers on Chemistry, Physics, and Chemical Technology, H. Lloyd Snape, B.Sc. (Lond.), E. L. Rhead, Ernest Bentz, G. H. Hurst. The day classes commenced on August 31st, 1886, and the evening classes will commence on September 27th, 1886. First year: Lectures upon the Chemistry of the Non-metallic Elements, and of the more commonly-occurring Metals. Second year: Lectures upon the Purer Metals, Organic Chemistry, and Chemical Philosophy. In the Laboratories instruction is given in Qualitative and Quantitative Analysis. Practical classes are also held in the Metallurgical and Dyeing Laboratories. Technical Students have opportunity to attend, and are urged to join classes in mechanical drawing, and to take practical manual exercise in wood and metal working. Special practical work in any branch of Chemical Technology, or in preparation for University Examinations, will be arranged to suit individual Students. The evening Courses of instruction are especially designed to meet the wants of those already engaged in various industries. A syllabus, containing full particulars as to hours, fees, &c., may be obtained from Mr. J. H. Reynolds, The Technical School, Manchester.

School of Science and Art, Newcastle-on-Tyne.—Chemistry and Metallurgy, Mr. P. Hawkridge, B.A.

Queenwood College, near Stockbridge, Hants.—Mr. M. Whitley Williams, F.C.S. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction.

Sheffield Borough Analysts' Laboratory, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

University of Aberdeen.—Mr. J. S. Brazier, F.C.S.

School of Medicine, Surgeon's Hall, Edinburgh.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, and Mr. Drinkwater.

Edinburgh School of Pharmacy and Chemistry.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Secretary, Mr. R. Urquhart.

Edinburgh School of Medicine, 41, Chambers St.—Dr. Drinkwater, F.C.S.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

Minto House Medical School, Chambers Street, Edinburgh.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

New Veterinary College, Leith Walk, Edinburgh.—Professor Ivison Macadam.

Glasgow University.—Prof. J. Ferguson.

Glasgow Veterinary College.—Professor Cooke.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

Chemical Laboratory, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

Queen's College, Galway.—Dr. T. H. Rowney.

Royal College of Surgeons in Ireland.—Sir Charles Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

Dublin, Carmichael College of Medicine.—Dr. C. R. C. Tichborne.

Dublin, Catholic University.—Dr. Campbell.

Dublin, Dr. Steevens's Hospital and Medical College.—Mr. McHugh.

THE CHEMICAL NEWS.

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ON THE FRACTIONATION OF YTTRIA.*

By WILLIAM CROOKES, F.R.S., V.P.C.S.

Having already explained the methods of chemical fractionation, it may be useful now to describe some of the results yielded by an extended perseverance in these operations.

I must, in the first place, explain that my work has been confined to a limited and very rare group of bodies —the earthy bases contained in such minerals as samarskite, gadolinite, &c. These have been repeatedly put through the fractionation mill by other chemists, but the results have been most unsatisfactory and contradictory, no sufficiently good test being known whereby the singleness of any earth got out by fractionation could be decided, except the somewhat untrustworthy one of the atomic weight. I say *untrustworthy*, because it is now known that fractionation, unless it is pushed far beyond the point to which some Continental chemists have even carried it, is quite as liable to give *mixtures* which refuse to split up under further treatment of the same kind, as it is to yield a chemically simple body. This I have fully gone into in my paper "On the Methods of Chemical Fractionation." The unsatisfactory nature of fractionation work may be seen from expressions used, in private letters to me, by some of the eminent chemists who have almost made this method their own. One writes—"It is very tiresome working with the rare earths, as we never can be sure when we have got a definite result. There will never be an end to their history. I am very tired of it, and am much inclined to give it up." Another writes—"Unfortunately I commenced my researches on the rare earths with too little material, and I have not had the courage, at my age, to re-commence the work on more abundant material. The further I advance in my work the more I am convinced that no known method permits of the complete separation of these different earths one from the other." A third writes—"One loses so much material in the separations that it appears to me scarcely possible, with the material available, to arrive at a successful solution of the question." I could multiply similar quotations, all breathing the same almost despairing spirit.

It would certainly not have been prudent on my part to invite a time-honoured comparison, and "rush in" where so many eminent men "fear to tread," were it not that good fortune had placed in my hands a physical test for these obscure molecular goupings which is of the most exquisite sensitiveness. I refer to what I have for shortness called the Radiant-Matter test.

It is well known that a limited group of these rare earths, when phosphoresced *in vacuo*, yield discontinuous spectra. The method adopted to bring out the spectra is to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness. It is then put into a radiant-matter tube of the form shown in Fig 1, and the induction spark is passed through it after the exhaustion has been pushed to the required degree. The phosphorescence occurs beneath the negative pole. As each gaseous molecule, carrying its charge of negative electricity with it, strikes the earthy sulphate, it has a tendency to part with its charge, provided it finds a body ready to take up the electricity; otherwise it retains its charge. Bodies like yttrium sulphate, &c., easily take the electric charge, and under the stimulus phosphoresce, emitting light whose waves tend to collect round definite centres of length. The phosphorescent light which the discharge evokes is best seen in a spectroscope of low dispersion, and with not too narrow a slit. In appearance the bands are more analogous to the absoption bands seen in solutions of didymium than to the lines given by spark spectra. Examined with a high magnifying power all appearance of sharpness generally disappears: the scale measurements must therefore be looked upon as approximate only; the centre of each band may be taken as accurately determined within the unavoidable errors of experiment, but it is impossible to define their edges with much precision. The bands are seen much sharper when the current first passes than after the current has been passing for some time and the earth has become hot. On cooling the sharpness of the bands reappears.

As a general rule the purer the earth the sharper the band, and when impurities are removed to the utmost extent, the sharpness is such as to deserve the name of a line. This may be illustrated by mixing together yttria and lime. Lime phosphoresces with a continuous and yttria with a discontinuous spectrum. Mixed together, the phosphorescing energy of the lime does not spend itself over the whole spectrum but concentrates itself in greatly reinforcing the yttria bands. A molecule of yttria vibrating with a definite wave-length gives a nearly sharp line, but the molecule of lime with which it is weighted has no special tendency to vibrate to one wave-length more than another. The yttria induces

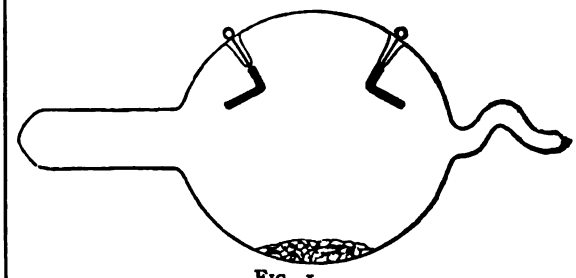


Fig. 1.

the right vibration in the adjacent molecule of lime; but this lime, once set in vibration, cannot confine itself to the exact wave-length required, and overflows a little on each side, and the result is a widening and blurring of the bands, becoming greater in amount as the extraneous earth increases in quantity.

To this rule one exception occurs. The body which I have named Sδ, or 609, is remarkable for the great sharpness of its phosphorescent line, and I have noticed scarcely any variation in its sharpness, however large the bulk of extraneous earth associated with it. This line, however, is sharper and brighter when the current is first turned on than it is after the earth has been phosphorescing for a minute or so.

In the Bakerian lecture on yttrium delivered before the Royal Society,* I described the phosphorescent spectrum given by this element, and in the address which I have had the honour of delivering before this section I gave a drawing of the spectrum of yttrium, together with a sketch of the train of reasoning by which I had been led to the opinion that excessive and systematic fractionation had split up this stable molecular group into its components, distributing its atoms into several groups, with different phosphorescent spectra.

No longer than twelve months ago the name yttria conveyed a perfectly definite meaning to all chemists. It meant the oxide of the elementary body yttrium. I have in my possession specimens of yttria from M. de Marignac (considered by him to be purer than any chemist had

* Read before the British Association, Birmingham Meeting, Section B.

* *Phil. Trans.*, Part 3, 1883.

hitherto obtained), from M. Cléve (called by him "purissimum"), from M. de Boisbaudran (a sample of which is described by this eminent chemist as "scarcely soiled by traces of other earths"), and also many specimens prepared by myself at different times and purified up to the highest degree known at the time of preparation. Practically these earths are all the same thing, and up to a year ago every living chemist would have described them as identical, *i.e.*, as the oxide of the element yttrium. They are almost indistinguishable one from the other both physically and chemically, and they give the phosphorescent spectra *in vacuo* with extraordinary brilliancy. This is what I formerly called yttria, and have more recently called *old* yttria. Now these constituents of old yttrium are not *impurities* in yttrium any more than praseodymium and neodymium (assuming them really to be elementary) would be impurities in didymium. They constitute a veritable splitting up of the yttrium molecule into its constituents.

The plan adopted in the fractionation of yttria does not differ in principle from the methods described in my former paper "On the Methods of Chemical Fractionation."

trate at the foot of the diagram (Fig. 2), where I give the spectra of five components of yttrium.

The final result to which I have come is that there are certainly five, and probably eight, constituents into which yttrium may be split. Taking the constituents in order of approximate basicity (the chemical analogue of refrangibility) the lowest earthy constituent gives a deep blue band Gα (λ 482); then there is a strong citron band Gδ (λ 574), which has increased in sharpness till it deserves to be called a line; then come a close pair of greenish blue lines, Gβ (λ 549 and λ 541, mean 545); then a red band, Gζ, (λ 619), then a deep red band, Gη (λ 647), next a yellow band, Gε, (λ 597), then another green band, Gγ, (λ 564); this (in samarskite and cerite yttria) is followed by the orange line Sδ (λ 609). The samarium bands remain at the highest part of the series. These, I am satisfied, are also separable, although for the present I have scarcely touched them, having my hands fully occupied with the more easily resolvable earths. The yellow band, Gε, and green band, Gγ, may in fact be due to a splitting up of samarium.

Until we know more about these bodies I refrain

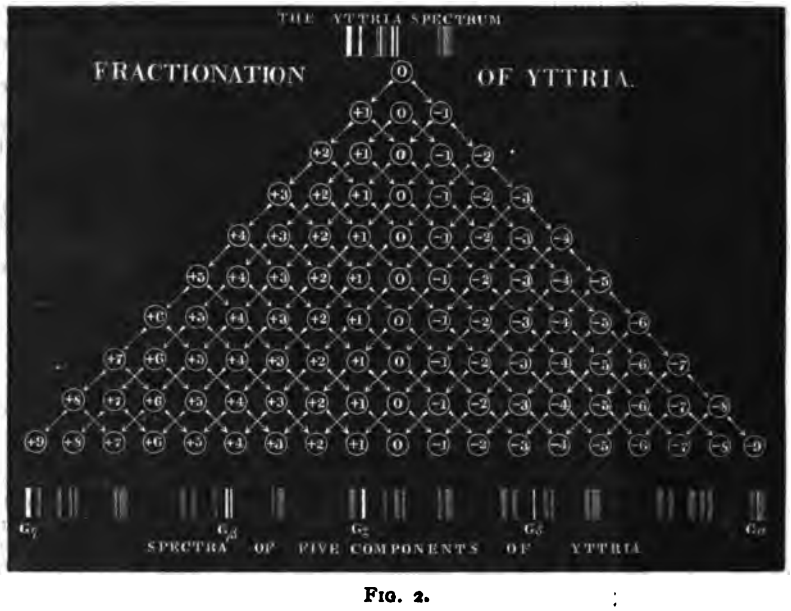


FIG. 2.

Dilute ammonia is added to a very dilute solution of the earth in only sufficient quantity to precipitate one half. After standing for several hours the precipitate is filtered. After each fractioning the filtrate is passed to the left and the precipitate to the right, and the operations are continued many thousand times.

The diagram (Fig. 2) shows the scheme clearly, with the direction the precipitates and solutions travel. Limited space, even on a large diagram, prevents me from giving more than a few operations, but they will be sufficient to satisfy you that enormous patience, a large amount of material, and a not insignificant number of bottles, are requisites for successful fractionation. Such proceedings are tedious enough even in their narration, but no mere words can enable any one to realise the wearisome character of these operations when repeated day by day, month after month, on long rows of Winchester quart bottles.

After a certain time, on examining the series of earths in the lowest line of bottles, their phosphorescent spectra are found to alter in the relative intensities of some of the lines, and ultimately different portions of the fractionated earths show spectra such as I have endeavoured to illus-

from naming them, but will designate them provisionally by the mean wave-length of the dominant band. If, however, for the sake of easier discussion among chemists a definite name is thought to be more convenient I will follow the plan frequently adopted in such cases, and provisionally name these bodies as shown in the Table. (See next page).

The initial letters S and G recall the origin of the earths respectively from Samarskite and Gadolinite.

Not only has yttrium been split up by subjection to fractionation, but samarium, as I have hinted above, is likely to prove equally unable to resist this operation. In the phosphorescent spectrum of samarium sulphate the line Sδ (609) is one of the constituents. When yttria is added to samaria this line is developed in greater intensity, as yttria has the power of deadening the other bands of samarium, while it does not seem to affect the line Sδ. Several circumstances, however, tend to show that although line Sδ accompanies samarium with the utmost pertinacity, it is not so integral a part of its spectrum as the other red, green, and orange lines. For instance, the chemical as well as physical behaviour of these line-forming bodies is different. On closely comparing the spectra of specimens of samarsk

Position of lines in the spectrum.	Scale of spectroscope.	Mean wave-length of line or band.	$\frac{1}{\lambda^2}$	Provisional name.	Probability.
Bright lines in—					
Deep blue	8·931	482	4304	Gα	New.
Greenish blue (mean of a close pair)	9·650	545	3367	Gβ	New, or the Zβ of M. de Boisbaudran.
Green	9·812	564	3144	Gγ	New.
Citron	9·890	574	3035	Gδ	New, or the Zα of M. de Boisbaudran.
Yellow	10·050	597	2806	Gϵ	New.
Orange	10·129	609	2693	Sδ	New.
Red..	10·185	619	2611	Gζ	New.
Deep red	10·338	647	2389	Gη	New.

from different sources, line Sδ varies much in intensity, in some cases being strong and in others almost absent; the addition of yttria is found greatly to deaden the red, orange, and green lines of samarium, while yttria has little or no effect on the line Sδ; again, a little lime entirely suppresses line Sδ, while it brings out the samarium lines with increased vigour. Finally, attempts to separate line Sδ from samarium and those portions of the samarskite earths in which it chiefly concentrates has resulted in sufficient success to show me that, given time enough and an almost inexhaustible supply of material, a separation would not be difficult. These facts, together with the peculiar behaviour of the lines Gϵ and Gγ, strengthen my suspicion as to the resolvability of samarium.

Samaria giving the line Sδ had been prepared from cerite and samarskite. Many observations had led me to think that the proportion of band-forming constituents varied slightly in the same earth from different minerals. Amongst others, gadolinite showed indications of such a differentiation, and therefore I continued the work on this mineral. Very few fractionations were necessary to show that the body giving line Sδ was not present in the gadolinite earths; no admixtures of yttria and samaria from this source giving a trace of it. It follows therefore that the body whose phosphorescent spectrum gives line Sδ occurs in samarskite and cerite, but not in gadolinite.

It now became an interesting enquiry whether all these constituents of yttrium were united together in exactly the same proportion in every case. A glance at the diagram before you will show that yttrias from different sources, although they may be alike as far as our coarser chemical tests are concerned, are not built up exactly in the same manner. Thus, when the samarskite yttrium was forming, all the constituent molecules—which I have provisionally named Gα, Gβ, Gγ, Gδ, Gϵ, Gζ, Gη, and Sδ—condensed together in fair proportion. In gadolinite yttrium the constituents Gβ and Gδ are plentiful, Gζ is very deficient, Sδ is absent, and the others occur in moderate quantities. In the yttrium from xenotime Gδ is most plentiful, Gβ occurs in smaller proportion, Gζ is all but absent, and Sδ is quite absent. Yttrium from monazite contains Gβ and Gδ, with a fair proportion of the other constituents, Gβ is plentiful and the red is good. Yttrium from fluocerite is very similar to that from monazite, but Gα is weaker. Yttrium from hielmite is very rich in Gδ, has a fair quantity of Gα and Gβ, less of Gγ, no Sδ, and only a very faint trace of Gη. Yttrium from euxenite is almost identical with that from hielmite. Yttrium from cerite contains most Gζ and Cδ, less Gα and Gβ, only a trace of Gη, and a fair proportion of Sδ.

I have already mentioned how the key to these explanations was gained by an examination of the phosphorescent spectrum of M. de Marignac's Yα (now called by him gadolinium).

Referring to the diagram it is seen that Yα is composed of the following band-forming bodies:—Gβ, Sδ, Gζ, together with a little samarium. Calling the samarium an impurity, it is thus seen that gadolinium is composed of at least three simpler bodies.

It is by a method of his own, differing from mine, that M. de Boisbaudran has obtained phosphorescent spectra of some of the rare earths. He takes the induction spark between the surface of a strong and acid solution of the metallic chloride, and a clean platinum wire a few millims. above it. The platinum wire is kept negative and the solution positive; it is then observed that in many cases a thin layer of fluorescent light is seen at the surface of the liquid. This layer gives a spectrum of nebulous bands. For the sake of brevity I will adopt M. de Boisbaudran's term, and call this process the *method of reversion* (the direction of the spark being reversed). As this method is entirely different to the one I adopt, it is not surprising that the results also are different. Experimenting in this way M. de Boisbaudran has obtained, among others, two bands (λ 573 and λ 543·2), which he considers are caused by two elements, named respectively Zα and Zβ, and which he considers new, at all events if we except terbium and possibly the elements of what was formerly called holmium. His method fails to show any spectrum in solutions of yttria which by my method give the yttria bands with the greatest brilliancy; while conversely his method shows a fluorescent spectrum in solutions of earths separated as widely as possible from yttria, chemically as well as spectroscopically. My experiments on both these methods tend to the conclusion that our bands are not due to the same cause, although M. de Boisbaudran's experiments have led him to the opposite conclusion. The band of Zβ (543) falls between the double green band Gβ and the band of Zα (573) would come very near the citron line Gδ.

In the hands of a practised experimentalist like M. de Boisbaudran this method may give trustworthy indications, but I must confess that in my opinion the test is one beyond the range of practical analysis, owing to the enormous difficulty of getting the phenomena described by the discoverer. Unless the strength of spark, the concentration and acidity of solution, and the dispersion and magnifying power of the spectroscope bear a certain ratio one to the other, the observer is likely to fail in seeing a spectrum even in solutions of earths which contain considerable quantities of Zα and Zβ. In my own case I not only have had the advantage of personal instruction in Paris from M. de Boisbaudran himself in the best method of getting these reversion spectra, but on returning to London I brought with me some of the identical earths which give these spectra at their best. In spite of these advantages I have sometimes experimented off and on for weeks without being able to see more than a feeble glimmer of the bands described by M. de Boisbaudran.

Again, when everything is most favourable and the reversion bands are at their strongest, they are but a faint and hazy shadow of the brilliant lines given by the bombardment process. M. de Boisbaudran, speaking of the relative sensitiveness of our two methods, says that the bombardment process *in vacuo* is incomparably more delicate than his reversion test, and I estimate the relative sensitiveness of the two methods to be in the proportion of about 1 to 100.

You have probably anticipated in your minds a question which is likely to occur at this point of the enquiry. If such results have been obtained by submitting yttrium to this novel method of analysis, what will be the result of fractionating some other reputed element?

Yttrium, as I have explained, is an exceedingly stable molecular group, capable of acting as an element, just as calcium, for instance, acts as an element: to split up yttrium requires not only enormous time and material, but the existence of a test by means of which the constituents of yttrium are capable of recognition. Had we tests as delicate for the constituent molecular groups of calcium, this also might be resolved into simpler groupings. It is one thing, however, to find out means of separating bodies which we know to be distinct and have colour or spectrum reactions to guide us at every step; it is quite another thing to separate colourless bodies which are almost identical both in chemical reaction and atomic weight, especially if we have no suspicion that the body we are dealing with is a mixture.

(I mention calcium because it is one of several other elements which I have put through the fractionation mill. Many hundred operations have given me just sufficient encouragement to make me wish I had time to push this work to the end).

One of the chief difficulties in the successful carrying out of an investigation in radiant matter spectroscopy is the extraordinary delicacy of the test. This extreme sensitiveness is a drawback rather than a help. To the inexperienced eye one part of yttrium in ten thousand gives as good an indication as one part in ten, and by far the greater part of the chemical work undertaken in my hunt for spectrum-forming elements was performed upon material which later knowledge shows did not contain sufficient to respond to any known chemical test. It is as if the element sodium were to occur in ponderable quantity only in a few rare minerals seldom seen out of the collector's cabinet. With only the yellow line to guide, and seeing the brilliancy with which an imponderable trace of sodium in a mineral declares its presence in the spectrum, I venture to think that a chemist would have about as stiff a hunt before he caught his yellow line as I have had to bring my orange and citron bands to earth.

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces" and when an analysis adds up to 99·999, the odd 0·001 per cent is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·999 per cent constitutes the impurity and this exiguous 0·001 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and the solubility of nearly all precipitates when present in traces in water or in ammoniacal salts. What is here meant by "traces" will be better understood if I give an instance. After fifteen months' work I obtained the earth yttria in a state which most chemists would call absolutely pure, for it contained not more than one part of impurity (samaria) in two hundred and fifty thousand parts of yttria. But this one part in a quarter of a million profoundly altered the character of yttria from a radiant-matter-spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another ten months' extra labour to eliminate these final "traces" and to ascertain the real reaction of yttria pure and simple.

The radiant-matter test applied to these phosphorescing bodies proves itself to be every day more and more valuable, and one of the most far-searching and trustworthy tools ever placed in the hands of the experimental chemist. It is an exquisitely delicate test capable of being applied to bodies which have been approximately separated, but not yet completely isolated, by chemical means; its delicacy is unsurpassed even in the region of spectrum analysis; its economy is great, inasmuch as the test involves no destruction of material, and its convenience is such that any given specimen is always available for future reference. Likewise, the quantity of material is limited solely by the power of the human eye to see the body under examination. Beyond all these excellences is its trustworthiness. I should perhaps exceed the legitimate inference from experience were I to claim that this test is infallible; but this I may say—during the five years in which the test has been in daily use in my laboratory, I never once have been led to view its indications with suspicion. Anomalies and apparent contradictions have cropped up in plenty; but a little more experiment has always shown that the anomalies were but finger-posts pointing to fresh paths of discovery, and the contradictions were due to my own erroneous interpretation of the facts before me.

NEW COLORIMETRICAL ESTIMATION OF SULPHUR IN IRON.

By J. WIBORGH.*

THE colorimetrical method of determining the amount of sulphur in iron which Prof. v. Eggertz worked out and published in 1860, in the *Jern Kontorets Annaler*, has been and still is indisputably of great utility to the Swedish iron manufacture. The method since then is in general use in our iron-works, and has incited me to proceed in the same direction. I have sought to perfect such a colorimetrical process as would be applicable also for greater amounts of sulphur than that for which the Eggertz method is intended. This new colorimetrical sulphur test will, I hope, fulfil the demands that in general may be put upon the practical requirements intended in the method; namely, it is quick and easy to execute, also it has sufficient accuracy to give the amount of sulphur, whether in cast-iron, steel, or wrought-iron. I proceed to a description of the method.

Basis of the Method.

Iron dissolves completely in diluted sulphuric acid or hydrochloric acid, and the gases evolved—hydrogen, carburetted hydrogen, and sulphuretted hydrogen—pass through a cloth impregnated with a metallic salt, and through the action of sulphuretted hydrogen a metallic sulphide is formed, which colours the cloth. From the intensity of the colour afterwards the amount of sulphur in the iron is decided.

I proceed here upon the assumption that a given surface is always coloured equally strong by a fixed quantity of sulphur. But to obtain an equal quantity of sulphur from two specimens of iron which have unequal amounts of sulphur, evidently the amounts of iron weighed out must be inversely proportionate to the amounts of sulphur. Therefore a weight W of an iron with sulphur amount S gives the same colour as a weight W′ of another iron with sulphur amount S′; so must—

$$W S = W' S';$$

and as S′ is the amount of sulphur sought—

$$S' = \frac{W S}{W'}.$$

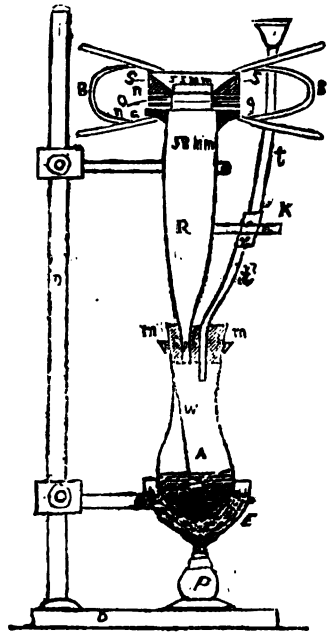
If you have thus an iron (normal iron) with the amount of sulphur accurately known, you can, by varying the amounts of it weighed out, produce a colour-series in which for every colour you know the product W S. This colour-series constitutes a scale with the aid of which

* Translated from the *Jern Kontorets Annaler*, 1886, p. 105, by J. Crum, Lowther Iron Works.

the unknown amount of sulphur S' in another iron can be determined by dividing the same colour's known product, W S, by the weight of the iron used for the assay.

The apparatus shown in the accompanying figure consists of a small boiling flask, A, provided with a close-fitting caoutchouc stopper, *m*, in which are placed a glass cylinder, R, with one end drawn out to a tube, P, and the other end having a flat polished flange, G, also a funnel tube, T, to introduce the acid. This latter consists properly of two, T and T', united with a caoutchouc tube, over which is placed a nipper tap, K, with a screw, so that the quantity of acid to be passed into the flask may be accurately regulated. Upon the cylinder flange is placed a caoutchouc ring, N, and upon this the prepared cloth, O. That the ring may close tightly against the flange and cloth, lay upon the cloth another caoutchouc ring, N', of the same size as the former, and outermost a wooden ring, S, which is pressed against the flange by the spring B.

These caoutchouc rings ought to have a precise inside diameter, for upon the size depends how much of the surface of the cloth will be coloured; as shown by the drawing it is made less than the opening of the cylinder, because it is easier to obtain such rings of a precise size



than the glass cylinder. In the apparatus represented the diameter of the ring O is 55, and the opening of the cylinder 58 millimetres.

In order that no steam may condense upon the ring S, and run down to the cloth, it is best to make this ring of wood rather than of glass or metal, of the size and form shown in the drawing.

By the arrangement now described neither gas nor steam can come from the apparatus without first passing through the cloth.

To heat the flask to boiling it is placed upon a sand-bath, E, which rests upon the stand D, and is heated by means of a gas or spirit lamp, P.

Preparation of the Cloth.

In the beginning I used, instead of cloth, unglazed paper, such as filter-paper, but I soon found that cloth was much more serviceable. Such paper certainly permits steam and gas to pass, but it is tender, and easily breaks asunder with the least incaution while boiling.

The cloth used is common, fine, white cotton calico. Linen is less suitable, for it is thin, and therefore does not absorb so easily all the sulphuretted hydrogen as evolved. The preparation of the cloth is simply to moisten it with a solution of a metal salt. For this may be employed either lead, silver, copper, cadmium, or antimony salts; but of all these I have found cadmium salts were for this purpose the most serviceable.

Silver and lead salts are certainly very sensitive to sulphuretted hydrogen; but the combinations of these metals with sulphur are black, and colour the cloth too strongly, so that it will be necessary to employ small weighings of the sample or extravagantly large apparatus.

Copper salts certainly give brownish and considerably softer colours, but, in consequence of the property of the sulphide to enter into variable combinations with the oxide, they are easily oxidised, and not permanent.

Antimony has few soluble salts, and besides in one case these are seen to be less sensitive to sulphuretted hydrogen; they are little fit for this purpose. A sufficiently dark colour is obtained by mixing the salts,—as, for example, cadmium and lead salts,—but has not led to any good results, as the colour comes out uneven, darker upon some places than upon others, so that the cloth has a more or less flannel-like aspect, varying between yellow and black.

For these reasons I have selected cadmium salt alone for the preparation of the cloth, and this the rather as the sulphur combination of cadmium is a particularly beautiful and constant yellow colour; also that the affinity of this metal for sulphur is so great that it surpasses that of lead.

When the cloth is impregnated with a mixture of cadmium and lead acetate, equal parts of each, and then exposed to a small quantity of sulphuretted hydrogen, the cloth at first will be almost exclusively yellow, and by the passage of more sulphuretted hydrogen it becomes dark, which shows well that the gas is sooner decomposed by cadmium than by lead. Again, concerning which of the cadmium salts ought to be selected for impregnation of the cloth it appears to be a matter of indifference which is employed, although the colour tint will be somewhat different as one or other salt is used.

Cadmium nitrate gives a singularly high and strikingly beautiful orange colour; the sulphate is somewhat weaker, with brownish yellow tint, while the chloride and acetate give lighter colours.

The colours occasioned by the varying amounts of sulphur may perhaps be most easily judged separately when the cloth is prepared with cadmium nitrate; but notwithstanding I have likewise used the acetate, because I think it likely that this salt, which has the weakest and most volatile acid, ought to give colours that would be least changeable, which property is of considerable weight.

In order that all the sulphuretted hydrogen may be absorbed by the cloth, it must contain a certain amount of cadmium salt in proportion to the largest quantity of sulphur which may possibly be present, otherwise a portion of the sulphuretted hydrogen will pass through the cloth, colouring yellow not only the under side, but also the upper side.

A solution of 5 grms. crystallised cadmium nitrate in 100 c.c. distilled water is of suitable strength.

Cloth of the proper fineness, prepared with such solution, allows not a trace of sulphuretted hydrogen to pass through, for the cloth was coloured only on the under side, and when double folds were used the upper had not the faintest colour.

The general influence of the degree of concentration of the solution is that the colours from strong solutions lie more upon the surface of the cloth, and that of weaker solutions it penetrates deeper into the cloth; and this causes a certain unevenness in the aspect of the colour, although the amount of sulphide of cadmium in both cases are alike. The influence of a smaller variation in the degree of concentration is not perceptible.

The cloth is prepared by cutting, on a round model, several folds to about 80 m.m. diameter. These are laid in the solution of cadmium acetate, care being taken that each circle is thoroughly saturated by the solution. After some minutes take out the pieces, and spread them out on a clean cloth until completely dried; then place them for safety in a suitable box.

The Colour Scale.

According to the quantity of sulphuretted hydrogen which reacts upon the prepared cloth, so is it covered with different amounts of cadmium sulphide, and receives a more or less yellow colour. The sensibility in this respect is so great that indeed 1000th part of a m.grm. of sulphur is able to communicate to the surface of a square centimetre of the white cloth a certainly weak, but yet very manifest, yellow colour. Increase successively the amount of sulphur by 1000th part of a m.grm. per square centimetre; you obtain by this small addition of sulphur from the first a clear distinction in the intensity of the colour; but in proportion as the strength of the colour increases with the augmented amounts of sulphur, the difference will be all the more difficult to observe. When the amount of sulphur increases to about 0·02 m.grm. per square c.m., the cloth is now strongly coloured, and to produce a manifestly distinct difference of colour intensity it requires two or three times greater excess of sulphur than with the lower colour estimations. Consequently you cannot with advantage make use of very strong colours, because the difficulty of their comparison is considerably increased.

In order to determine the amount of sulphur in an iron you must first have a colour series, or scale of colours, whereon every colour number represents a certain amount of sulphur per cent, presupposing that a certain quantity of iron has been weighed out for assay.

This colour series can be easily procured by the help of a normal iron in which the amount of sulphur has been determined beforehand with the greatest accuracy. How great the amount of sulphur this normal iron may contain is quite immaterial, but use the most trustworthy among the known methods of determining sulphur in iron by oxidation of the sulphur, and thereafter precipitating by chloride of barium. With small amounts of sulphur this is to a certain degree unsafe, so it is better to use for the scale an iron with a pretty high amount of sulphur, such as about 0·1 per cent, because the influence of a small error in this determination of the sulphur will be less.

If you have a known amount of sulphur S, also an iron of which 0·4 grm. is weighed out, and its amount of sulphur is S', to obtain the same colour from both of the irons must—

$$W \times S = 0{\cdot}4 \times S'$$

Or—

$$W = \frac{0{\cdot}4 \times S'}{S}.$$

In this formula place, instead of S', the successive amounts of sulphur per cent, as 0·005, 0·01, 0·02, &c. As you know how much of the normal iron in every case ought to be weighed, so that you may have a series of colours that are entirely the same as those which shall be obtained if you had different irons with their respective amounts of sulphur and of each 0·4 grm. weighed; you get, in other words, a colour scale, where colours give directly the amount of sulphur the iron contains.

If you make up such a scale for the apparatus shown in the sketch, with the inner ring 55 m.m. diameter, you can under the supposition that 0·4 grm. has been weighed for testing: it is not desirable to go farther than this, so that the highest colour number corresponds to 0·1 per cent sulphur, because otherwise the colours will be too strong. Nevertheless you must not take between the high colour numbers a greater difference in the amount of sulphur than between the lower, if the different colour intensities shall be clearly separated from each other.

For example, you can allow the scale to be composed of seven colour numbers, taken thus:—

No. 1	corresponding to	0·005	per cent	sulphur.
2	,,	0·01	,,	,,
3	,,	0·02	,,	,,
4	,,	0·03	,,	,,
5	,,	0·05	,,	,,
6	,,	0·07	,,	,,
7	,,	0·1	,,	,,

If thus 0·4 grm. iron is weighed for assay, one can, with the help of the above scale, determine the amount of sulphur up to 0·1 per cent. The accuracy wherewith the determinations is done are, for the lower of amounts of sulphur at least, to −0·005 per cent, and for higher 0·01 per cent, for the differences between the colours of the scale are here so great that one with the greatest ease can estimate a colour lying between two colour numbers.

The same scale may, however, be used to determine quickly whatever amount of sulphur is desired, if only the weight of iron used for assay be varied. It is obvious that absolutely the same colour which an iron gives from 0·4 grm. must be got from another iron with half as much sulphur, if 0·8 grm. has been weighed; and that, in general, if 0·4 *n* is weighed, the colour scale comes to represent sulphur amounts which are $\frac{1}{n}$ of those that answer to the weight 0·4 grm.

One ought therefore to use in general greater amounts for assay, when low amounts of sulphur shall be determined with great accuracy, also lesser quantities for high amounts of sulphur.

In the case of the colour coming out too strong—lying upon the margin or beyond the greatest amount of sulphur in the scale, the assay ought to be made with a lesser weight.

To avoid calculation one can, under every colour number, place not only the amount of sulphur which corresponds to that weighed out in making the scale, but also that which corresponds to some other weighings which possibly may occur. Note the following weighings, W, also the corresponding amounts of sulphur, S, per cent:—

0·8 gramme.		0·005 per cent.	
0·4	,,	0·01	,,
0·2	,,	0·02	,,
0·1	,,	0·04	,,
0·08	,,	0·05	,,
0·04	,,	0·1	,,
0·02	,,	0·2	,,

With these different weighings are thus given the colour numbers of the amounts of sulphur from 0·005 per cent to 0·2 per cent.

Having by the above method prepared the different colour numbers which form the scale, they may be arranged in order upon small white drawing-paper, bound, and preserved in a suitable portfolio.

When cadmium acetate is used for the preparation of the cloth, the colour will be very constant. They have undergone no sensible change for several months, though preserved only in the above manner. One such scale ought to be made for every apparatus, and observe that the cloth used for the preparation of the scale must be the same sort as that afterwards used for testing.

Details of the Process.

Rinse every part of the apparatus with water, so that no acid remains from the former assay. The boiling-flask is half filled with distilled water; then fit the apparatus together and place on the sand-bath, which is heated by means of a gas- or spirit-lamp, so that the water in the flask comes to gentle boiling. While heating, weigh out the iron to be tested. This may certainly be in the form of small pieces, but, that the solution may not proceed too slowly, it is best if the iron is in the form of filings, turnings, or powder. Difficultly soluble iron, such

No.	Sorts of iron tested for sulphur by Wiborgh's colorimetric method and by chloride of barium.	By Wiborgh's method.	By wet method with chloride of barium.	
		Sulphur, p.c.	Sulphur, p.c.	Determined by—
1.	White charcoal cast-iron	0·005	0·005	A. Tamm.
2.	Spiegeleisen from Siegen, with 0·05 per cent copper	0·005	0·006	J. Wiborgh.
3.	Bar iron, with 0·076 per cent arsenic	0·007	0·008	Y. Lagervall.
4.	Casting	0·0075	0·005	A. Tamm.
5.	Grey charcoal cast-iron	0·0075	0·005	A. Tamm.
6.	White „ „	0·012	0·01	J. Wiborgh.
7.	Casting	0·012	0·014	A. Tamm.
8.	Half-white charcoal cast-iron	0·018	0·018	J. Wiborgh.
9.	Malleable casting	0·015	0·013	N. Lagerfelt.
10.	White charcoal cast-iron, with 0·071 per cent arsenic	0·02	0·025	Y. Lagervall.
11.	White charcoal cast-iron	0·02	0·02	J. Wiborgh.
12.	Malleable casting	0·023	0·024	E. v. Zweigbergk.
13.	White charcoal cast-iron	0·023	0·024	Y. Lagervall.
14.	„ „ „	0·025	0·022	A. Tamm.
15.	„ „ „	0·028	0·029	J. Wiborgh.
16.	Cast-iron melted with copper, containing 1·55 p.c. Cu	0·039	0·038	„
17.	Siemens-Martin iron	0·04	0·037	„
18.	„ „	0·05	0·047	„
19.	White charcoal cast-iron, with 0·015 per cent Cu	0·06	0·061	„
20.	Steel	0·07	0·068	„
21.	Siemens-Martin iron	0·1	0·093	„
22.	Grey cast-iron	0·135	0·134	Y. Lagervall.
23.	Cannon cast-iron	0·15	0·145	J. Wiborgh.
24.	White cast-iron from Hörde, with 1·88 per cent P	0·21	0·19	E. Aquilon.
25.	Malleable casting	0·35	0·34	J. Jungner.
26.	White cast-iron from coke	0·45	0·46	J. Wiborgh.
27.	„ „ „	0·7	0·66	P. G. Lidner.

as white iron,—high in silicon, phosphorus,—chrome iron, &c., ought always to be finely pulverised.

The weighed sample is brought, by means of a small funnel and hair-pencil, into the test-tube, *r*. This test-tube has the mouth widened. It is set in a loop made on the end of a platinum wire, w, which is bent over the edge of the test-tube, as shown in the figure, so that the platinum wire may not slip over the tube and rest on the bottom of the flask, which ought to be avoided, because the test-tube may take such a position that the access of the acid to the iron may be made difficult. The platinum with which the test-tube is thus fastened ought to be rather stiff—about 0·3 m.m. diameter.

After the water has boiled two minutes, and the air has been expelled, take out the stopper with the cylinder attached. The test-tube with the sample is lowered into the flask, where it rests on the bottom, held upright by the platinum wire.

Put the apparatus together again, and upon the cylinder flange lay the above-mentioned caoutchouc ring, 55 m.m. in diameter, and over it the prepared cloth, another caoutchouc ring, and lastly the wooden ring, all which are pressed together by the spring clamp.

As soon as the cloth is laid on screw up the clamp k on the funnel-tube, and steam must now pass through the cloth.

Partly to get the air as much as possible driven out of the apparatus, and partly to moisten the cloth, maintain the water in gentle boiling for about eight to ten minutes before any acid is introduced. Then fill the funnel-tube with diluted sulphuric acid (for example, ¼ volume sulphuric acid, 1·83 sp. gr., and ¾ volume water). Open carefully the screw-clamp k, and allow the acid to drop into the flask. For 0·4 grm. iron use about 10 c.c. dilute acid.

As soon as acid comes down the solution of the iron begins; steam and gases pass through the cloth, and in proportion as the solution proceeds, also according to the amount of sulphur in the iron, the under side of the cloth is more strongly coloured yellow.

After all the iron is dissolved, boil the solution further from five to ten minutes, to drive out the sulphuretted hydrogen which yet remains in the apparatus. Then open the spring clamp, remove the bottom ring, and lay the cloth upon a piece of filter-paper to dry completely. It only remains now to determine the amount of sulphur by comparing the colour of the cloth with the colour scale.

That the liquid in the flask during the whole period is maintained at an even but *gentle boiling* is very essential for this process. The boiling ought to be so strong that the steam is always seen to pass through the cloth, but by no means so violent that the cloth becomes stretched by the boiling. For when it happens that the cloth, in consequence partly of this stretching and partly from the condensed steam, becomes more and more close, and takes a strongly convex form, then the pressure in the apparatus increases, so that on the introduction of the acid the gases formed rush through the funnel-tube. With cautious boiling one need never fear such occurring.

In order to avoid oxidation of the sulphuretted hydrogen formed during the solution of the iron, it is of importance that before the acid is introduced into the flask the air is as completely as possible expelled from the water and the apparatus, also that the boiling is so strong that plenty of steam always accompanies the gases which pass through the cloth.

The cloth in the assay ought to be coloured evenly, for if the colour is uneven it very considerably increases the difficulty of estimating the colour strength.

Whether the colour comes out even or not depends chiefly upon the construction of the glass cylinder. It ought to be so accurately made that the centre line of the tube coincides with that of the cylinder. Further, the tube ought to be short and of a conical form, 7 to 8 m.m. diameter at the lower end.

If the tube is too wide the cloth is always coloured unevenly; and again, if it is too small, drops of water condensed in the tube are cast up on the cloth, which give it a spotted aspect. The drawing represents the cylinder so set in the caoutchouc stopper that the mouth of the tube is even with the under side of the stopper; but it is still better to allow the end of the tube to be 5 to 10 m.m. under the stopper. It is certainly now more difficult for the water to leave the tube, and causes—especially at first, before the cylinder becomes warm—a weak bubbling; but this has no hurtful influence, but contributes to the more evenly colouration of the cloth.

Observe, further, that the glass cylinder is placed by the eye as vertical as possible, also that the apparatus is not placed in a draught.

The time required for a sample is half to three-quarters of an hour, according as the iron is more or less soluble.

This new method, in many special experiments, has given most satisfactory results, in that it is independent of the amounts of carbon and silicon in the iron, indicating high as well as low amounts of sulphur in iron, as seen in the accompanying Table with sulphur determinations in different sorts of iron. These have been performed by this method, and controlled by accurate estimations of the sulphur by the wet method. (See Table preceding page).

I have also tested if some impurities in iron—such as copper and arsenic—had any influence upon this method. For this purpose several sorts of iron containing copper and arsenic were specially selected from the collection of the Mining School; and in the Table it is found—

I. In the samples 2, 16, and 19 copper has no action; also—

II. In samples 3 and 10 the same is probably the case with arsenic, for the certainly somewhat large difference in the sulphur determination which occurs in sample 10 must be sought in other circumstances, as sample 3—even with its small amount of sulphur and high amount of arsenic—shows no noticeable difference.

The apparatus may be made of whatever size is wished, but in relation to use in Sweden it is seldom necessary to examine iron with a greater amount of sulphur than 0·1 per cent. I regard an apparatus with an inner ring of 55 m.m. as diameter of a suitable size. On the other hand, if one has in general to test iron with high amounts of sulphur, as cast-iron made with coke, &c., I would recommend that the apparatus be made somewhat larger.*

EMBOLITE: ITS COMPOSITION AND FORMULA.

By CUTHBERT WELCH.

(Concluded from p. 95.)

V. 3AgCl.2AgBr.

	A.	B.	C.	D.	Theory.
AgCl ..	52·793	52·8	53·2	53·4	53·378
AgBr ..	47·207	47·2	46·8	46·4	46·622
	100·000	100·0	100·0	99·8	100·000
	Or,				
Ag	66·862	66·85	66·9	66·94	66·956
Br	20·088	20·09	19·9	19·82	19·839
Cl	13·050	13·06	13·2	13·18	13·205
	100·000	100·00	100·0	100·00	100·000

A. Plattner, from Colorado Mine, Copiapo, Chili. (*Poggendorff's Annalen*, lxxvii., 134).

B. Domeyko, from Chanarcillo, Chili. ("Elementos de Mineralogia," 1845, 203). Asparagus green.

C. Colonel P. Yorke, from Chanarcillo, Chili. (*Quarterly Journal of Chemical Society*, iv., 149, 1852).

D. F. Field, from Chanarcillo, Chili. (*Quarterly Journal of Chemical Society*, x., p. 239, 1858). Dark green.

VI. 5AgCl.2AgBr.

Domeyko, (*Annales des Mines*, (4), vi., p. 153, 1844), and ("Elements de Mineralogia," 1845, p. 203). Colour pearly greyish green. From Chili. A. From Chanarcillo. B. From Quillota.

	A.	B.	Theory.
AgCl	65·6	66·4	65·615
AgBr	34·4	33·6	34·385
	100·0	100·0	100·000
	Or,		
Ag	69·14	69·28	69·066
Br	14·63	14·30	14·632
Cl	16·23	16·42	16·302
	100·00	100·00	100·000

VII. 5AgCl.6AgBr.

Mr. J. M. H. Munro, from St Arnaud (CHEMICAL NEWS, liii., p. 99, 1886).

		Theory.
AgCl	39·276	38·378
AgBr	60·724	61·122
	100·000	100·000
	Or,	
Ag	64·45	64·357
Br	25·84	26·009
Cl	9·70	9·634
	99·99	100·000

VIII. 6AgCl.AgBr.

Domeyko, from Chanarcillo, Chili. (*Annales des Mines*, (4), vi., p. 153, 1844). Pearly greyish green.

		Theory.
AgCl	81·4	82·078
AgBr	18·6	17·922
	100·0	100·000
	Or,	
Ag	71·94	72·090
Br	7·92	7·605
Cl	20·14	20·305
	100·00	100·000

IX. 7AgCl.2AgBr.

Domeyko, from Chanarcillo, Chili. (*Annales des Mines*, (4) vi., p. 153, 1844).

		Theory.
AgCl	72·9	72·763
AgBr	27·1	27·237
	100·0	100·000
	Or,	
Ag	70·44	70·410
Br	11·53	11·590
Cl	18·03	18·000
	100·00	100·000

X. 7AgCl.5AgBr.

Domeyko, from Chanarcillo, Chili. (*Annales des Mines*, (4) vi., p. 153, 1844.) Asparagus green.

		Theory.
AgCl	51·0	51·658
AgBr	49·0	48·342
	100·0	100·000
	Or,	
Ag	66·54	66·659
Br	20·85	20·562
Cl	12·61	12·779
	100·00	100·000

Surely it cannot be contended that three substances possessing, respectively, 20·297, 43·288 and 82·078 per cent of AgCl are the same mineral with but an allowable variation in composition.

* Complete apparatus with colour scales and prepared cloth can be obtained either through the author or F. O. Söderberg, Mining School, Stockholm.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 102.)

XV. *Relation between Silver and Bromide of Ammonium*, γ 51.

Bromide of ammonium.	Equivalent in silver.	Ag : NH_4Br = 100.
10·77165	11·85891	90·83169*
10·31995	11·36168	90·83121
20·43458	22·49766	90·82981 *m*
11·27594	12·41414	90·83144*
13·40256	14·75537	90·83173 M
24·36270	26·82197	90·83113
8·93490	9·83692	90·83025
	Average	90·83104*
	Log =	1·9582343

The bromide in the last determination was prepared by Deville.

All the samples of chloride and bromide of ammonium sublimed without leaving the least trace of any residue.

XVI. *Syntheses of Nitrate of Silver*, β 281.

Two series of syntheses have been effected. The silver used in the first series contained traces of silica, (α 237—251). I have, therefore, only calculated the two estimations published in 1865, which were carried out with infinite care. M. Stas considers these determinations to be absolutely irreconcilable with Prout's hypothesis, and he has suggested that a chemist of established scientific reputation should repeat this synthesis. Nobody having come forward in answer to his appeal, he himself repeated it in 1882 (β 305; γ 65).

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.

The estimations of 1860 and 1865 are tolerably close; but still there remains an uncertainty of $\frac{1}{10000}$ as to the exact composition of nitrate of silver. In fact, nitrate of silver, dried at its melting-point, on being re-melted gives off some traces of acid vapours. Once melted it no longer loses weight, even when kept liquid *in vacuo* for fourteen hours (α 249).

During the years 1860 and 1865, M. Stas believed it more rational to consider the melted nitrate as the normal compound (α 251; β 286).

But in 1882, he seemed to lean towards the belief that the dried nitrate was more exact (γ, 62, 72, 73, 77). I admit my incompetence to decide this point, which has such a decided influence on the atomic weight of nitrogen. (See Table A).

M. Stas has also determined the relation between nitrate of silver and the chlorides of potassium and ammonium, (α 293—294).

The hygrometric property of the melted nitrate has caused an uncertainty of more than 1 m.grm. on a weight of 10 grms. to 30 grms. Further, the saline limit only has been determined, and the variation between the several results is greater than in the other estimations carried out by M. Stas.

I have, therefore, thought it necessary to eliminate these series of experiments, which would not help in determining the atomic weights founded on a surer basis.

XVII. *Relation between the Chloride and the Nitrate of Potassium*, β 244.

The weight in air is the only weight which is given with these salts. M. Stas has only applied the reduction for vacuo to the averages; he considers this correction to be = 0·003. To arrive at this figure, it is necessary to admit that the specific weight of the nitrate is 2·018 if that of the chloride is 1·950. (The weight of 1 litre of air is 1·28 grm.)

All the samples of chloride of potassium contained silica, which did not change in weight by the action of

TABLE A.

Silver.	Nitrate of Silver. Dried at its Melting-point.	Nitrate of Silver. Melted.	Ag : $AgNO_3$ = 100. Dried.	Ag : $AgNO_3$ = 100. Melted.
136·2952	214·6600	214·6462 ?	157·4963 M	157·4862*
82·3231	129·6555	129·6420	157·4959* *m*	157·4795
		Average	157·4961*	157·4828*
		Log. =	2·1972699	2·1972333

TABLE B.

Chloride of Potassium.	Nitrate of Potassium.	KCl : KNO_3 = 100 roughly.	Chloride produced.	Silica per 100,000.	Correction for Silica.	Relation corrected for Silica and for Vacuo.
50·7165	68·7938	135·6438	Nitre	5 to 6	0·0021	135·6429
80·2610	108·8665	135·6406*	Chloride of Potassium	5	0·0018	135·6394
72·1022	97·8050*	135·6478	Chloride of Potassium	5	0·0018	135·6466
50·2175	68·1200	135·6499	Chloroplatinate of Potassium	2 to 2·5	0·0009	135·6478 M
48·9274	66·3675*	135·6449	Chloroplatinate of Potassium	2 to 2·5	0·0009	135·6428
69·8836	94·7900	135·6398	Chloroplatinate of Potassium	5	0·0018	135·6386 *m*
14·2578	19·3415	135·6556	Old figures	?	?	
					Average	135·6430
					Log. =	2·1323974

TABLE C.

Chloride of Sodium.	Nitrate of Sodium.	NaCl : NO_3 = 100 roughly.	Chloride produced.	Silica per 100,000	Correction for silica.	Relation corrected for Silica and for Vacuo.
120·0110	174·5590	145·4525	Carbonate	5	0·0023	145·4498 *m*
32·4837	47·2550	145·4730*	Chloroplatinate of Sodium	3·5	0·0016	145·4696 M
68·1295	99·1045	145·4649	Chloroplatinate of Sodium	4·?	0·0018	145·4617
47·9226	69·7075	145·4585	Chloroplatinate of Sodium	4·5	0·0020	145·4555
					Average	145·4592
					Log =	2·1627412

nitric acid. $\frac{1}{10000}$th of silica diminishes the relationship by 0·000356. (See Table B).

The last experiment was omitted in calculating the average.

XVIII. *Relation between Chloride and Nitrate of Sodium*, β 248.

The reduction for vacuo is, according to M. Stas, 0·005. As chloride of sodium has a specific weight of 1·145, that of the nitrate should be 2·276. The fifth experiment has been elimated, because the glass retort used was not acid proof. (See Table C).

The second determination was made with the collaboration of Kekulé. In 1882 M. Stas showed preference for the three last experiments (γ 63).

XIX. *Relation between Silver and Chloride of Lithium*, β 268.

There were only a few experiments made with lithium, and, in spite of their agreement, M. Stas hesitates in saying that the atomic weight of lithium is not 7·00. The saline limit only was found.

Chloride of Lithium.	Equivalent in silver.	Ag : LiCl = 100.
7·88452	20·0335	39·3567 *m*
6·9210*	17·5843	39·3590*
10·96584	27·8597	39·3609 M

Average 39·3589*
Log. = 1·5950430

The chloride of lithium was weighed *in vacuo*, and contained absolutely no fixed residue.

XV. *Relation between Chloride and Nitrate of Lithium*, β 274.

Chloride of Lithium.	Nitrate of Lithium.	LiCl : $LiNO_3$ = 100.
23·0260	37·43756	162·5882 *m*
30·8542	50·16835	162·5981*
34·1700	55·5605	162·6003* M

Average 162·5955
Log. = 2·2111085

The weights are already reduced for vacuo.

(To be continued).

NOTICES OF BOOKS.

The Methods of Glass-Blowing. By W. A. Shenstone. London: Rivingtons.

The want of a practical treatise on glass-blowing has long been felt, and the work now before us satisfies this want in a very satisfactory manner.

Until within the last few years glass-blowing was generally looked upon as an art beyond the power of most students, skilful amateurs being regarded as something out of the common; while the glass-blowing *trade* was kept in the hands of a very few men, all known to each other, and who kept up the prices of even simple work to an almost prohibitive figure. But the law of supply and demand has once more asserted itself in a striking manner: the introduction of incandescent lamp-making has in a few years entirely altered this state of things, and it is now not an uncommon thing to see girls of 14 and 15 years of age turning out work which quite recently was looked upon as a creditable performance for a man of mature age. This result has been brought about by careful tuition, and a book such as this one will surely be of great value to those who have little or no opportunity of seeing the operations of glass working actually done.

The first chapter is devoted to a description of the apparatus necessary, and the most convenient arrangement of the same. The different varieties of glass are next dealt with, and the characteristics of good glass are detailed.

The third and fourth chapters describe, step by step, the manner of making such apparatus as are generally used in chemical and physical laboratories, while the fifth and last chapter gives directions for calibrating vessels and etching on glass.

The only point to which we might take exception is the Appendix, which gives thirty-six diagrams said to represent the diameter and thickness of the tubes most frequently required, each pattern being designated by a number. In a somewhat extended experience we do not remember to have heard glass tube referred to by these or any other numbers, while, on the other hand, the sizes of tube made run so imperceptibly from one to the other that it would be difficult to say where to draw the line between one number and the next.

Report of Proceedings of the Michigan Board of Health Regular Meeting, July 13th, 1886.

At this meeting Dr. Victor C. Vaughan, Professor of Physiological Chemistry in the University of Michigan, made an important communication concerning *tyrotoxicon*. This is a very poisonous ptomaine, developed under certain circumstances in cheese and in milk. Its presence in cheese was recognised about a year ago, as reported in the *Zeitschrift für Physiolog. Chemie* (vol. x., Part 2), and the *Annual Report of the Michigan State Board of Health for* 1885.

A serious case of poisoning from ice-creams, which took place lately at Lawton, in the same State, has again called attention to the subject. Prof. Vaughan uses the following method for its isolation:—The coagulated milk was filtered through thick Swedish-paper. The filtrate, which was colourless and of a distinctly acid reaction, was rendered faintly alkaline with potassium hydrate and agitated with ether. The ethereal layer, after it has separated, is drawn off with a pipette, passed through a dry filter-paper to remove a suspended white flocculent substance, and allowed to evaporate spontaneously. If necessary the residue may be re-dissolved in water and again extracted with ether. On the evaporation of the ether the tyrotoxicon is recognised by its crystalline appearance, its odour, and its action on the tongue.

Dr. B. C. Moffit, of Lawton, one of the sufferers from the ice-cream case, thus describes the symptoms observed:—"About two hours after eating the cream everyone was taken with severe vomiting and afterwards with purging. The vomit was of a soapy character. There was some griping of the stomach, with severe occipital head-ache, excruciating back-ache, and bone pains all over. Even after ten days the symptoms do not entirely disappear." Dr. Vaughan experimented on himself with the pure poison, and experienced very similar results. The circumstances under which the poison is generated require further investigation.

The author suggests that "a little dried milk formed along the seam of a tin pail, or a rubber nipple, tube, or nursing-bottle not thoroughly cleansed, may be the means of generating, in a large quantity of milk, enough of the poison to render it highly harmful to children."

Dr. Vaughan's paper and the cases which gave rise to it are very suggestive as regards the possible dangers of the street ice-cream trade.

The author has not yet obtained sufficient tyrotoxicon for quantitative analysis.

Phosphorography applied to the Photography of the Invisible.—Ch. V. Zenger.—Images of a number of bodies can be obtained in the dark when, like calcium carbonate, paper, &c, they possess the property of slowly re-emitting the light which they have absorbed during insulation.—*Comptes Rendus*, Vol. ciii., No. 9.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 8, August 23, 1886.

On the Purple of the Solar Spectrum.—C. Kœchlin.—This memoir will be inserted in full.

No. 9, August 30, 1886.

At the opening of the session the President formally conveyed to Prof. Chevreul the congratulations and good wishes of the Academy on the centenary of his birthday. Several foreign *savants* were officially present to join in the congratulations, to which the veteran chemist replied with profound emotion.

Atomic Weight of Germanium.—Lecoq de Boisbaudran.—The mean value found by Prof. Winkler from the determination of the chlorine in four specimens of germanic chloride is 72·32, which agrees well with the author's determinations, obtained on theoretical principles, and showing respectively 72·28, 72·32, and 72·27.

No. 10, September 6, 1886.

Fluorescence of the Compounds of Manganese, submitted to the Electric Effluve in a Vacuum.—Lecoq de Boisbaudran.—The fluorescences of the manganese compounds are remarkable from the variety and the brightness of their colours, and from their spectral resolution into a characteristic band, which varies in aspect and position with the nature of the manganiferous substance. Manganese sulphate alone (previously heated to dull redness according to the process devised by Mr. Crookes for the rare earths) does not fluoresce appreciably in a vacuum. Mn_3O_4, derived from the ignited carbonate, gives nothing. Calcium sulphate alone (after ignition to dull redness) gives merely a faint fluorescence with a continuous spectrum; but if it contains a little manganese sulphate it is illuminated with a splendid green tint. A trace of manganese suffices to produce this fluorescence. With 1-100th of manganese sulphate the fluorescence is fine, and with 1-20th superb. The spectrum is continuous, but it contains neither the red nor the violet. It is a very broad band, beginning indistinctly about $\lambda = 660$, having its maximum intensity about 540, and terminating vaguely between the blue and the violet. Calcium carbonate, not previously ignited, is scarcely illuminated at all in a vacuum. After strong ignition it yields a fluorescence generally of a violet blue at the points most directly exposed to the action of the electrode, violet at a little distance, and bluish green further off. The supposed pure calcium salts are rarely free from strontium, which gives a fine blue fluorescence. With the same calcium carbonate rendered slightly manganiferous we obtain, after strong ignition, a splendid orange-yellow fluorescence. The light is condensed in a brilliant band beginning vaguely about $\lambda = 670$, having its maximum intensity about 589, the end of its chief luminosity about 553, and losing itself about 526. With 1-100th MnO the fluorescence is very fine, constituting a reaction still more sensitive than the green fluorescence of calcium sulphate with manganese sulphate. Magnesium sulphate alone, heated for a moment to dull redness, gives only a feeble greenish white fluorescence, but a little manganese sulphate enables it to fluoresce with a splendid redness. Zinc oxide, pure or manganiferous, ignited, gave no appreciable fluorescence. Zinc sulphate alone, after heating to dull redness, yielded merely a pale rose fluorescence with a continuous spectrum. But if it contains a little manganese sulphate there appears, after ignition, a splendid red fluorescence of a shade less inclining to orange than that of magnesium sulphate, with a little manganese sulphate. Analogous observations have been made with cadmium, strontium, lead, and glucinum sulphates, in all which cases a striking fluorescence was produced by the addition of a little manganese sulphate.

Moniteur Scientifique, Quesneville. 3rd Series, Vol. xvi., August, 1886.

Patents for Colouring-Matters granted at Berlin in March and April, 1886.—These comprise: Process for the preparation of new azo colouring-matters, yellow, red, and blue, by means of the bidiazo-derivatives of the ethers of the diamido-diphenols, of the phenols, or the amines.—F., No. 2585, Nov. 18, 1885.

Basic colouring-matters obtained by diazotising meta-nitraniline and combining these diazo-derivatives with meta-phenylene-diamine.—L., No. 3262, Aug. 4, 1885.

Preparation of blue sulphuretted colouring-matters.—R., No. 3467, Dec. 29, 1885.

Preparation of Aldehyds of the quinoleic series.—F., No. 2635, Dec. 28, 1885.

Preparation of blue rosanilines, soluble in water, by the action of aromatic diamines upon the rosanilines. Oxidation upon the fibre of the colours obtained with these new colouring-matters.—D., No. 2536, March 10, 1886.

Preparation of indulines soluble in water by the reaction of the aromatic diamines upon the amido-azo compounds. Oxidation of these colouring-matters upon the fibre.—D., No. 2535, March 10, 1886.

German Review.—G. Serracin.—A number of extracts from the *Berichte der Deutschen Chem. Gesellschaft.*

On Saccharine.—From the *Journal of the Society of Chemical Industry.*

Application of Electricity in Metallurgy.—M. Vedrinsky.—In this extensive memoir the author describes the electrolytic refining of copper, the Marchese electrolytic process, and the Cowles process for smelting metals by electricity.

Use of Explosive Matters for Working Engines.—M. Razeuvaieff.—The author undertakes to prove that engines fed with nitro-compounds can never compete economically with steam-engines.

New Contributions to the Determination of Tannins.—H. R. Procter, F.C.S.—From the *Journal of the Society of Chemical Industry.*

New Notes on the Methods of Examining Fixed Oils and on their Chemistry.—A. H. Allen.—From the *Journal of the Society of Chem. Industry.*

Manufacture of Toilet Soaps.—Dr. Alder Wright, F.R.S.—Also from an English source.

Documents on Quinine.—Dr. O. Hesse.—From the *Pharmaceutical Journal.*

Absorption of Potassium and Calcium Bicarbonates by the Rootlets of the Beet.—H. Leplay.—From the *Comptes Rendus.*

Patents in the Chemical Arts taken out in France.—The usual list for March last.

The Question of Coal-dust.—R. Galloway.—From *Nature.*

Properties and Proprietors of Ungreenable Aniline Black.—A continuation of the acrimonious discussion on ungreenable aniline blacks.

French Association for the Advancement of Sciences.—This Association has held its 15th session at Nancy under the presidency of M. Friedel. The meeting began on the twelfth and concluded on the 19th ult.

Industrial Society of Mulhouse: Session of the Chemical Committee.—June 9.—With reference to the prize proposed by M. Camille Kœchlin for an albumen steam orange not affected by steaming, M. Jacquet remarked that he had produced an orange of this kind six years ago by adding to the albumen chrome-orange, cad-

mium nitrate, and sodium acetate. M. Kœchlin replied that his proposed prize did not refer to means for preventing the sulphuration of chrome-oranges, but contemplated a new orange, free from lead.

Reale Academia dei Lincei.

This contains a memoir by Augusto Righi on the cause of rotatory magnetic polarisation. He considers that the hypothesis by which Fresnel explains natural rotatory polarisation lacks experimental confirmation, since, in the case of quartz, the separation of the incident ray into two opposite circular rays obtained with the double or triple prism of Fresnel may be regarded as a special phenomenon of diffraction, whilst, in the case of bodies endowed with a rotatory magnetic power, the experiments of interference made to show a different velocity of propagation of the circular rays may be interpreted in another manner.

Journal de Pharmacie et de Chimie.
Vol. xiv., No. 4, August 15, 1886.

Decomposition of Hydrofluoric Acid by the Electric Current.—H. Moissan.—Already inserted.

Urethane from an Analytical Point of View.—Georges Jacquemin.—On treating a 1 per cent solution of urethane with a 5 per cent solution of mercuric chloride and then with potassa at 5 per cent there is formed an abundant white precipitate. This precipitate can be distinctly obtained in some c.c. of a solution containing 1·50 grms. of urethane in a litre of water. The author names this precipitate mercuric carbamate. Theoretically 0·1 of urethane dissolved in 10 c.c. of water and mixed with potassa in decided excess should be completely precipitated as a white mass by 10 c.c. of a standard solution of mercuric chloride at 1·522 per cent, and that, on adding a drop more, there should be produced a persistent yellow precipitate marking the completion of the operation. Experiment, however, showed that not 10 c.c. but 20 c.c. of the standard mercuric solution must be employed for the complete precipitation of 0·1 grm. of urethane. It is necessary to add a large excess of potassa to the urethane operated upon, and to stir with a rod after each addition of mercuric chloride. Very near the end of the operation there appears a very faint yellow tint, which must not be confounded with the yellow precipitate indicating the end of the operation.

Determination of Lime in Bone-Black.—P. Guyot.—In determining this lime it is common to boil a weighed quantity of the black with a solution of ammonium chloride and collect the free ammonia liberated, deducing from its quantity that of the quicklime. But as calcium carbonate in the states of chalk, limestone, &c., also decompose ammonium chloride, the volume of ammoniacal gas given off does not indicate the quicklime present.

On Chlorozone.—Drs. Lunge and Landolt.—The substance of this note has already appeared.

Essence of Boulogne is obtained by treating chloride of lime stirred up in water with sulphuric acid at 12° B., and receiving the gases in weak soda-lye.

Stannous Chloride as a Disinfectant.— Stannous chloride is considered equally effective with mercuric chloride, and has the advantage of being perfectly innocuous (?)

Centenary of the Death of Scheele.—This event was celebrated at the little town of Köping, in Sweden, on May 21, 1886.

Reagent for Sugar in Urine.—Into a test-tube, which should not be filled more than one third, are poured 5 to 6 c.c. of the urine to be tested; 1 c.c. of a solution of potassium ferrocyanide is added, then 1 to 1½ c.c. of potassa lye, and the whole is repeatedly boiled. If no sugar is present the liquid retains its yellow colour; if it contains sugar it becomes of deep brownish red.

Toxicity or Non-Toxicity of the Compounds of Copper.—After a long discussian the Belgian Academy of Medicine rejected the two following propositions which had been submitted by Dr. Du Moulin, viz:—"Copper combined with articles of food in the proportions usually met with is not dangerous." "Especially the greening of preserved vegetables with copper salts is absolutely inoffensive." The Academy, on the contrary, adopted the following proposition, which will be transmitted to the Government:—"The compounds of copper are not merely useless in foods; they are injurious."

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Griess's Test.—Can any of your readers tell me what chemical changes occur when meta-phenylene-diamine is acted upon by nitrous acid?—J. O. W. B.

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All communications should be addressed to MR A. NORMAN TATE, 9, Hackins Hey, Liverpool, as, owing to similarity of surname with that of the principal of another chemical establishment in Liverpool, misconception and mistakes have arisen.

THE CHEMICAL NEWS.

Vol. LIV. No. 1401.

ON SOME PROBABLE NEW ELEMENTS.*

By ALEXANDER PRINGLE.

The subject of my paper is some of the results of chemical work upon the mineral constituents of my own landed property. That property is situated upon the River Tweed, in the county of Selkirk. It is mountainous. The rocks are believed by geologists to belong to the Lower Silurian formation, or, in other words, to be very old, and they have been uncommonly free from volcanic disturbance. The chief disturbances they have undergone have been caused by glaciers, weathering, and rain.

This subject is described as a paper "On some Probable New Elements." I had no expectation whatever of finding any new elements, but only a slight hope of getting some of the rarer ones in small quantity, such as might suffice to please a chemist if he found them upon his own estate.

I commenced my work upon the veins of crystalline quartz in the valleys, because these might be expected to contain within their interstices the filtrate from the rocks. Some of them were blocked up with ferric oxide and basic ferric salts. By working upon these I met with some mineral acids which were new and strange to me, and perplexing. But the labour of crushing the quartz was considerable, and the yield smaller than I can describe. I therefore tried to trace out the source from whence they came. It was evident they must have dissolved iron, and that the ferrous salts thus produced had travelled through the rocks in company with ferrous carbonate, and that the mixture, emerging into the open air, had precipitated basic ferric salts of unknown acids among other substances. Therefore I went up on to high ground, and followed the track of ferric precipitates. This track led me along the glacier lines to their extremity,—that is to say, to a high ridge over which the glaciers must have fallen, and here it ceased. Beneath the turf was gravel, which had evidently been deposited by the falling glaciers, for very many of the stones were shaped as they are in a "moraine profonde." A small waterfall had excavated fully 7 feet of this gravel, and when I stood in the drip of it, and could see within, I saw at the bottom what was like an asphalte pavement. This proved to be the main source of the iron, and gave a rich yield of the curiosities for which I had been searching.

I imagine it was the ancient soil of these very ancient mountains, and therefore represented, if I may so say, the cream of the rocks,—that glaciers had carried off nearly all of it into the Old Red Sandstone sea near Melrose, where its contents would be so distributed as to be difficult of recognition to chemists, but that at the spot where I found it the glaciers had covered it with their own *débris*, and thus protected it from their own action and from subsequent rains. When I got this glimpse of it Nature had recently formed the waterfall, but has since covered it up again, and the iron stains have disappeared that pointed out the way to it. I have found another similar deposit above the glacier lines.

The element which I am best prepared to describe is the one that has given me most trouble. I thought it judicious to tackle the chief difficulty first, because unless I could separate this element out I could not get the others in a state of purity. As I required to give it a name, even for my own convenience in making notes, I called it Polymnestum (Pm), because its compounds combined with those of several other elements all at one time, and I had a difficulty in getting them away in combination with any one in particular, either as a precipitate or in solution.

This element is a metal of rather dark colour, but I have not yet succeeded in fusing it so satisfactorily as to venture upon its description. Its equivalent is about 74, but before speaking definitely on this point I wish to try more experiments, as my results hitherto have varied by a few decimals.

There are four oxides. In the first of these one equivalent of the metal is combined with one of oxygen, in the second with two, and in the third with three. As to the fourth I have some doubt as yet, but will describe it in its place as far as I can.

The monoxide is bright green, and its hydrate white. Its salts are some of them green and some white. It is soluble in solutions of all the alkalies and alkaline carbonates. With the fixed alkalies these solutions are green. The monosulphide is not precipitated from them till after the lapse of a long time. Then it falls like ferrous sulphide, of a dark green colour. When dried, even in sulphuretted hydrogen, this becomes nearly white, but regains the dark colour when moistened. It dissolves in weak acids, such as the acetic. The sulphate of the monoxide, which is white, is insoluble in water, in excess of sulphuric acid, and in all other acids. It dissolves, however, in concentrated sulphuric acid, and is re-precipitated upon dilution. It also dissolves when boiled with carbonate of soda, and is of course re-precipitated by any acid. The metal, therefore, can be very well separated out as sulphate of the monoxide. The oxalate forms with the alkalies double oxalates, which are sparingly soluble. Salts of the monoxide give white precipitates with iodide of potassium, and with borates and phosphates. If tartaric acid be added to them, and then an alkali, the tartrate precipitates without boiling. It is white and crystalline, but if long exposed to the air effloresces and becomes green. If it is heated with nitrate of ammonia the mass swells up, producing the dioxide. It then takes fire and leaves the trioxide. The monochloride when once dried is not readily dissolved by water. It is white, and gives no reaction with ferrocyanide or ferricyanide of potassium. If the dichloride is heated in hydrogen it is reduced only to this monochloride, and as such volatilises at a very moderate heat. Solutions of the salts corresponding to the monoxide are very liable to pass into those corresponding to the dioxide through lapse of time, but they can be reduced to their former condition by treatment with tartaric acid.

The dioxide resembles in appearance ferric oxide. Most of its salts are soluble and yellow. I am acquainted with an insoluble basic sulphate which is yellow, and basic acetate which is fawn-coloured. But the best precipitant I know of is sulphide of ammonium. The disulphide is dark brown, insoluble in acetic acid, but soluble in hydrochloric acid when freshly precipitated. The dichloride is white when dry, but yellow in solution and deliquescent. It is not soluble in alcohol or ether. It gives with ferrocyanide of potassium a white precipitate, and with ferricyanide a yellow one. The salts of the dioxide form double salts with those of ammonia which are not precipitated by ammonia, but fixed alkalies precipitate the dioxide.

The trioxide is white. It is not fused or volatilised at a white heat. It dissolves very slightly in pure water, a little more in hydrochloric, nitric, or dilute sulphuric acid, and more still in hot concentrated sulphuric acid. If its solution in water or a dilute acid is treated with sulphuretted hydrogen a pale yellow sulphide falls, which dissolves in alkaline sulphides, and is easily oxidised by heating with nitric acid. It appears to be a sesquisulphide. The trioxide acts the part of an acid. It is not easily made to combine even with caustic potash in the wet way, though it does so readily when the alkali is fused. It forms double salts with the alkalies and many

* Read before the British Association, Birmingham Meeting, Section B.

metallic oxides. Most of its salts are soluble; they are not decomposed by sulphuric or any other acid at any temperature; they give precipitates in presence of strong acids with salts of baryta, strontia, mercurous oxide, and lead oxide, and in presence of acetic acid with salts of lime. The barium precipitate is the most complete under all circumstances; it is not at all decomposed by boiling with alkaline carbonates for two hours, but it is so by fusion with them. In short, the salts of the trioxide greatly resemble sulphates, but they are even more stable, and form double under a great many circumstances. If the trioxide is heated with chlorate of potash or nitrate of ammonia it is further oxidised, becoming pink.

I am unwilling to believe, without the evidence of repeated experiments, that a pentoxide is here produced, but the following experiment appears to prove that it is so:—I heated 100 grains of the sulphate of the monoxide with nitrate of ammonia till the weight was constant, and it was then 89·6 grains. This corresponds to five equivalents of oxygen and one of the metal taken as 74·01. Scarcely any remnant of sulphur could be detected by fusing with sodium and testing with nitro-prusside of sodium. Nessler's test showed no ammonia to be remaining, and sulphate of brucine no nitric acid.

The qualitative test which I use for detecting this metal is as follows:—I see that if the metal is present it must be as a salt of the trioxide. This can be done by fusing a mineral with caustic alkali and dissolving with hydrochloric acid, or by dissolving with hydrochloric and heating for some time with nitric acid. I then precipitate from the strongly acid solution with chloride of barium, and heat the precipitate with about half its bulk of sodium. This is sure to show some of the green monoxide, which is very characteristic. I then usually test with nitro-prusside of sodium to see whether any part of the barium precipitate was sulphate. The advantage of using sodium, which should be in one lump, is that it does not reduce the whole precipitate equally. In whatever proportion the trioxide may be present, that which is next the sodium will be reduced to metal, and what is farther off to monoxide. An additional test is to reduce all to metal which ought to be insoluble in hydrofluoric, hydrochloric, and nitro-hydrochloric acids; but if part of the precipitate was sulphate, some of the monosulphide will be formed which dissolves in acids. A third test is to heat the precipitate with chlorate of potash, and see whether the product is pink.

I have indicated that I believe there are other new elements in the mineral in question, but I shall only mention these now in the briefest possible manner.

One of them greatly resembles iron, and is slightly attracted by the magnet; it forms a monoxide, sesquioxide, and trioxide. The trioxide is exceedingly like the trioxide of the metal last described. But the most remarkable circumstance is that the sesquichloride yields a kind of prussian-blue. With sulphocyanides it gives no colouration and with tinctures of galls a light brown precipitate, and it can be easily distinguished from ferric chloride in other ways. The double salts, however, which it forms with the alkaline chlorides are very like the ferric ones. This prussian-blue is more beautiful, but less insoluble than ferric ferrocyanide.

Another metal, of which the equivalent is 95·4, is as black as charcoal, and its lowest oxide is almost equally dark coloured when dry and dense, though otherwise brown. I therefore call it Erebodium (Eb). I am best acquainted with the dioxide, which resembles oxide of bismuth in its tendency to produce insoluble basic salts, although not precisely in the same way, and there are no oxy-salts that I know of. There appears to be also a higher oxide, of a pink colour, like the highest one of Polymnestum, and obtained in the same way. The oxalates of this and the preceding metal are scarcely at all soluble in oxalic acid.

There is a metal which I call Gadenium (a local name). I usually find its equivalent to be 43·6, but I have also made it as low as 43·547. I have not yet tried to fuse it, but the powder is light grey. The monoxide is red, yielding white salts, and the dioxide cream-coloured, yielding yellow salts. One of the unusual precipitates it gives is the sulphocyanide.

Another metal, of which I cannot yet mention the equivalent with any certainty, resembles lead in colour and softness, and is easily fused and volatilised. It gives yellow and green salts, and in some respects is like nickel and cobalt.

Lastly, there is a non-metallic or semi-metallic element of which the equivalent is 45·2. I think it the most interesting of the group, and could describe it at considerable length. Its colour is red, and when it has a metallic lustre it looks so like a sunset sky that I have thought of calling it Hesperine, or perhaps Hesperisium (He). It has a monoxide, sesquioxide, and dioxide. The last two form acids which precipitate barium from acid solutions. In fact this element resembles selenium very much. It forms gaseous compounds with hydrogen and with fluorine, and combines with all the other elements at one temperature or another, except perhaps with nitrogen.

ON THE

ARSENATE OF CALCIUM AND AMMONIUM

By CHARLES L. BLOXAM.

In a recent communication to the CHEMICAL NEWS (vol. liv., p. 16) I recommended the addition of arsenic acid to a solution of calcium sulphate mixed with ammonia, for the detection of calcium in the presence of strontium. I then believed that the beautiful crystalline precipitate was the ammonio-calcic arsenate described by Wach (quoted in Gmelin's "Handbook," Watts's edition, vol. iv., p. 306) as containing, in 100 parts,—

NH_3.	2CaO.	AsO_5.	14HO.
5·35	17·52	35·83	41·15.

If this formula be written $NH_4O.2CaO.AsO_5.13HO$, the percentage of water (HO) becomes 38·32, whilst that required by the formula is only 37·26. The formula $NH_4O.2CaO.AsO_5.14HO$ requires 39 per cent, which agrees better with that found by Wach (38·32).

Gmelin remarks that "the resemblance of this compound to the phosphate of magnesia and ammonia leads to the supposition that the quantity of water which it contains does not exceed 13 atoms"—

($NH_3.2CaO.AsO_5.13HO$, or $NH_4O.2CaO.AsO_5.12HO$).

With regard to the phosphate referred to, the formula $NH_4O.2MgO.PO_5.12HO$ requires 44 per cent water. Wach found 45·06 per cent, and Otto found 45·15.

The formula $NH_4O.2MgO.PO_5.13HO$ requires 46·06 per cent water.

Analysis, therefore, gives rather more water than 12HO in the phosphate, and rather less than 14HO in the arsenate. In modern notation the former appears to be $NH_4.MgPO_4.6H_2O$, and the latter $NH_4.CaAsO_4.7H_2O$.

In "Watts's Dictionary" (i., 381) the salt—

$$CaNH_4HAsO_4 (Ca=20)$$

which, with Ca=40, would become—

$$Ca(NH_4)_2H_2(AsO_4)_2,$$

is described as having been obtained by Baumann, by adding ammonia in excess to a solution of dicalcic arsenate in nitric acid, as a flocculent precipitate soon changing to a mass of needle-shaped crystals. This behaviour corresponds exactly with that of the precipitate formed by adding arsenic acid to a solution of calcium chloride mixed with excess of ammonia, and the sudden transformation of the opaque amorphous precipitate into the transparent shining needles can be recommended as a class experiment. The precipitate is almost absolutely

insoluble in weak ammonia, though it dissolves slightly in water. Thinking it remarkable that an acid arsenate represented by Baumann's formula should be formed in a solution containing a large excess of ammonia, I proceeded to repeat the analysis.

(1.) A weighed quantity of Iceland spar was dissolved in HCl, the solution boiled to expel CO_2, mixed with NH_3 in large excess, and arsenic acid added until no further precipitation took place; the liquid was briskly stirred, set aside for a few minutes, the precipitate collected on an air-dried weighed filter, thoroughly washed with weak ammonia (sp. gr. 0·958), and exposed freely to the air, in July, until it had ceased to lose weight after an interval of eighteen hours. This required six days and nights.

10·06 grains $CaCO_3$ gave 32·15 grains of the air-dried precipitate.

$CaNH_4AsO_4.7H_2O$ requires 32·49 grains.
$CaNH_4AsO_4.6H_2O$ „ 30·68 „
Baumann's formula „ 35·81 „

Finding that the loss of weight was very small towards the end, and that the rate was uniform, the precipitate was weighed, in the following experiments, as soon as the loss of weight in eighteen hours had fallen to 0·1 grain.

(2.) 5·5 grains $CaCO_3$ gave 16·68 precipitate, or 323·9 per cent.

(3.) 6·15 grains $CaCO_3$ gave 19·92 precipitate, or 323·9 per cent.

$CaNH_4AsO_4.7H_2O$ requires 323 per cent.
$CaNH_4AsO_4.6H_2O$ „ 305 „

As there was no calcium found in the filtrate, all that present in the $CaCO_3$ employed existed in the precipitate, and would amount in (2) and (3) to 12·35 per cent. The formula requires 12·38 per cent.

(4.) 8·35 grains of the air-dried salt were dissolved in HCl, ammonium acetate added, the Ca precipitated with ammonium oxalate, and the filtrate precipitated by a mixture of $MgSO_4$, NH_4Cl, and NH_3. The—

$MgNH_4AsO_4.\frac{1}{2}aq$,

dried at 100°, corresponded to 22·78 per cent of arsenic.

$CaNH_4.AsO_4.7H_2O$ requires 23·22 per cent.

(5.) 7·765 grains of the air-dried arsenate were boiled with an excess of silver nitrate, which effected complete decomposition. The silver arsenate (Ag_3AsO_4) weighed 11 grains, corresponding to 1·7818 of arsenic, or 22·94 per cent. The filtrate had a very feebly acid reaction, and did not retain any silver arsenate in solution, showing that no nitric acid had been liberated, and that the arsenate was normal and not acid in constitution.

(6.) 8·05 grains of the air-dried salt were boiled with excess of potash, the NH_3 absorbed by standard sulphuric acid, the excess of which was determined by standard lime-water. The NH_3 amounted to 0·4253, or 5·28 per cent.

$CaNH_4.AsO_4.7H_2O$ requires 5·57 per cent.

(7.) 31·44 grains of the air-dried salt were exposed in the air-pump vacuum over sulphuric acid till there was no further diminution in weight of any importance. This required a fortnight's exposure. The loss amounted to 36·6 per cent of the weight of the air-dried salt.

(8.) 32·15 of another sample lost 37·41 per cent.

(9.) 8·2 grains of the vacuum-dried salt, boiled with potash, gave 2·96 per cent of NH_3.

(10.) 6·39 grains gave 2·89 per cent of NH_3.

(11.) 4·65 grains of the vacuum-dried salt were heated over an Argand burner in a small flask through which air was slowly aspirated. The loss amounted to 0·76, or 15·41 per cent.

(12.) 10·53 grains, in a similar experiment, lost 1·64 grains, or 15·57 per cent.

(13.) 5·52 grains thus heated, the ammonia being condensed in standard sulphuric acid, lost 0·86, or 15·58 per cent, and gave 0·1437 NH_3 = 2·6 per cent, leaving for the water 12·98 per cent.

(14.) 49·32 grains Iceland spar entirely converted, as in (1), into the ammonio-arsenate, and dried *in vacuo* over sulphuric acid, without previous air-drying, gave 100·3 grains of the salt, which therefore contained 19·67 per cent of calcium.

(15) 6·03 grains of the vacuum-dried salt, boiled with excess of silver nitrate and filtered, gave a strongly acid filtrate, which was found, by neutralising with standard solution of sodium carbonate, to contain 1·2256 grains of HNO_3, or 20·82 for 100 of the salt taken.

(16.) 5·96 grains of the vacuum-dried salt, treated as in (15), left undissolved 11·42 grains of Ag_3AsO_4, of which an additional 1.9 grains were precipitated on neutralising the filtrate with sodium carbonate. This corresponds to 36·2 per cent of arsenic.

These numbers represent the salt dried *in vacuo* over sulphuric acid as having the formula—

$Ca_3NH_4H_2(AsO_4)_3.3H_2O$,

which requires in 100 parts—

	Ca.	As.	NH_3.	Loss (NH_3 and H_2O) on ignition.
	19·46	36·82	2·78	16·03
Found	19·67	36·20	2·89	15·58
„	20·00	—	2·96	15·57
	—	—	—	15·41

The action of silver nitrate upon the salt would be expressed by the equation—

$$Ca_3NH_4H_2(AsO_4)_3.3H_2O + 9AgNO_3 = 3H_2O + 3Ag_3AsO_4 + 2HNO_3 + NH_4NO_3 + 3Ca(NO_3)_2.$$

This would require two molecules, or 126 parts by weight, of HNO_3 to be liberated on decomposing one molecule, or 611 parts by weight of the salt by silver nitrate; or 20·62 of HNO_3 should be liberated by 100 of the salt. In (15) the amount liberated was shown to be 20·82.

The change in composition of the air-dried salt by being exposed, at the common temperature, *in vacuo*, over sulphuric acid, is expressed by the equation—

$$3(CaNH_4AsO_4.7H_2O) = Ca_3NH_4H_2(AsO_4)_3.3H_2O + 2NH_3 + 18H_2O.$$

This would require the air-dried salt to lose 36·94 per cent *in vacuo*, In (7) it lost 36·6, and in (8) 37·41 per cent.

(17.) In order to ascertain the formula of the salt dried at 100°, 7·33 grains of Iceland spar were treated as before, and the precipitate dried in the water-oven till of constant weight. It weighed 14·66 grains, and therefore contained 20 per cent of calcium.

(18.) 10·49 grains $CaCO_3$ gave 21·35 grains of the salt dried at 100°; corresponding to 19·66 per cent of calcium. Hence the salt dried at 100° contains the same proportion of calcium as the vacuum-dried salt.

(19.) 7·52 grains of the salt which had been dried at 100°, when boiled with silver nitrate, gave a total quantity (16) of 18·1 grains Ag_3AsO_4; corresponding to 39 per cent of arsenic. The nitric acid liberated was 2·0228 grains.

(20.) 8·2 grains of the salt dried at 100°, when boiled with potash, gave 0·1191 grain of NH_3, or 1·45 per cent.

(21.) 8·995 grains gave 0·1471 grain of NH_3, or 1·64 pet cent.

(22.) 11·62 grains of the salt dried at 100°, heated as in (11), evolved 1·0976 of water, or 9·45 per cent, and 0·0524 grain of NH_3. On boiling the residue with potash it evolved 0·1242 grain more NH_3, making in all 1·52 per cent of NH_3.

These results give, for the salt dried in the water-oven, the formula $Ca_6NH_4H_5(AsO_4)_6.3H_2O$, which requires, in 100 parts,—

	Ca.	As.	NH_3.	H_2O.
	20·85	39·10	1·48	9·38
Found	20·00	39·00	1·45	9·45
„	19·66	—	1·64	—
	—	—	1·52	—

The action of silver nitrate upon this salt would be represented by the equation—

$$Ca_6NH_4H_5(AsO_4)_6.3H_2O+18AgNO_3=6Ag_3AsO_4+ +5HNO_3+NH_4NO_3+6Ca(NO_3)_2+3H_2O.$$

This would require five molecules, or 315 parts by weight of HNO_3 to be liberated by one molecule, or 1151 parts of the salt; or 27·37 of HNO_3 for 100 of the salt. In (19) the quantity liberated was 26·90 per cent.

The change in the vacuum-dried salt, when heated to 100°, is expressed by the equation—

$$2[Ca_3NH_4H_2(AsO_4)_3.3H_2O] = =NH_3+3H_2O+Ca_6NH_4H_5(AsO_4)_6.3H_2O.$$

This would require the vacuum-dried salt to lose 5·81 per cent at 100°.

By experiment the loss amounted to 5·77 per cent.

When the salt dried at 100° was ignited it became slightly brown, and the residue was feebly alkaline. When analysed it gave—

	I.	II.	III.	IV.	
Ca ..	25·8	25·00	25·74	25·58	per cent,
As ..	43·0	41·01	—	—	,,

the different samples varying a little in composition, as more arsenic was lost at higher temperatures, but agreeing fairly well with the formula $Ca_2As_2O_7$, which requires 23·1 per cent of calcium and 43·86 per cent of arsenic.

When boiled with silver nitrate it was not completely decomposed, but 13·73 of HNO_3 were liberated for 100 of Ag_3AsO_4 produced, which would justify the following equation, requiring 13·61 of HNO_3 for 100 of Ag_3AsO_4:—

$$Ca_2As_2O_7+6AgNO_3+H_2O= =2Ag_3AsO_4+2Ca(NO_3)_2+2HNO_3.$$

A little As_2O_3 and AsH_3 are evolved during the strong ignition of the salt.

It appears, therefore, that the precipitate produced by arsenic acid in a solution of calcium chloride containing free ammonia has the composition—

Air-dried	$CaNH_4AsO_4.7H_2O$
Dried *in vacuo* over sulphuric acid ..	$Ca_3NH_4H_2(AsO_4)_3.3H_2O$
Dried at 100°	$Ca_6NH_4H_5(AsO_4)_6.3H_2O$
Ignited	$Ca_2As_2O_7$.

In view of the trivalent function of the arsenate radical, AsO_4, these changes in the composition of the calcium-ammonium salt are the simplest which could occur.

Determination of Calcium as Ammonio-Arsenate.

The determination of calcium in this form has many advantages over the precipitation as oxalate. Being so highly crystalline the precipitate filters much more rapidly, and is not liable to run through the filter, as is often the case with the oxalate unless it is boiled in the liquid. The filtration and washing of the ammonio-arsenate are effected continuously, so that the operator may conclude them at once without turning to another subject. The calcium constitutes about one-fifth of the weight of the precipitate dried at 100°, whereas it forms about two-sevenths of calcium oxalate dried at 100°, so that errors tell more upon the calcium in the case of the latter. This source of error is of course still more important when the oxalate is converted into carbonate or oxide for weighing, and even as sulphate the weight is only about three times that of the calcium to be determined.

The disadvantages of the arsenate are that it must be washed with ammonia-water, and collected on a weighed filter, and that it must be dried for some hours in the water-oven. If it be ignited it suffers an uncertain loss of arsenic.

It has been pointed out above that the salt dried at 100° has a formula which requires 20·85 per cent of calcium, but if it be weighed after ordinary drying in the water-oven, the temperature of which is never quite 100°, it is safer to take it as containing 20 per cent of calcium, as the following experiments prove. They were made as in (1), the precipitates being collected on filters previously dried in the water-oven and weighed.

	I.	II.	III.	IV.
Ca taken (as Iceland spar)	2·932	4·116	4·024	3·936
Ca calculated as 20·85 per cent of precipitate.. ..	3·057	4·451	4·043	4·034
Ca calculated as 20 per cent	2·932	4·270	3·878	3·870

As a mean of these results, for 3·752 grains of calcium taken, 3·896 grains were found if the precipitate was calculated as containing 20·85 per cent of calcium, and 3·737 if 20 per cent was allowed, giving an excess of 3·83 per cent on the calcium in the former case, and a deficiency of 0·4 per cent in the latter.

The determination of the calcium as oxalate is susceptible of much greater accuracy than this in very careful hands, but the much greater volume of the arsenate renders it far easier to avoid loss.

The ammonia used for washing is that commonly used in the reagents, containing about 8·5 per cent by weight of NH_3, and I find it convenient to keep a rubber stopper fitted with washing-bottle tubes, which may be inserted in place of the stopper of the ammonia bottle. The precipitate is liable to crystallise on the sides of the beaker, especially if they be touched by the stirring-rod, but is easily detached.

The ammonio-arsenate method is very suitable for determining calcium in river and spring waters, on account of its volume being so much greater than that of the oxalate. Should the analyst prefer to convert it into oxalate instead of drying, it may be dissolved off the filter with acetic acid, and the solution mixed with ammonium oxalate. The magnesium contained in the water is also precipitated as ammonio-arsenate, and may be re-precipitated from the acetic solution filtered from the calcium oxalate, by adding excess of ammonia; the precipitate of magnesium ammonio-arsenate is collected on a dried weighed filter, washed with ammonia, dried at 100°, and weighed as $MgNH_4AsO_4.\frac{1}{2}H_2O$. I have found it much quicker to determine the Ca in waters in this way than by the old process. A much smaller quantity of water is necessary, and if the calcium be eventually required in the form of oxalate the bulk of liquid in which it is precipitated is not more than one-tenth of the original volume of water.

A very easy determination of the joint amount of Ca and Mg for checking the soap-test may be made by mixing 100 c.c. (or even less) of the water with excess of ammonia, and adding arsenic acid. After briskly stirring for a minute or two, and standing for ten minutes, the precipitate is collected on a dried weighed filter, and dried at 100° till constant. Half the weight of the precipitate may be taken as the weight of $CaCO_3$ (or its equivalent in hardness) present in the water. Since 100 of $MgCO_3$ correspond to 226 of the magnesian precipitate (instead of 200 as for calcium) the result is less accurate, as the proportion of Mg in the water is greater.

In applying this method to the water of the laboratory (Grand Junction) three determinations were made, 100 c.c. of water being taken for each: the ammonio-arsenate weighed 0·66, 0·67, and 0·68 grain, corresponding to a mean of 0·335 of $CaCO_3$, or 15·22 grains per gallon, a result almost identical with the hardness determined by the soap-test.

The last two precipitates were dissolved off the filters by acetic acid, the calcium precipitated by ammonium oxalate, and the precipitates, after boiling, collected upon the same filters, and dried at 100°.

The weights of $CaC_2O_4.H_2O$ obtained were 0·45 and 0·44 grain, corresponding to a mean of 0·3048 of $CaCO_3$, or 13·85 grains per gallon. On adding excess of ammonia to the filtrate a small precipitate of magnesium ammonio-arsenate was obtained, which could not be weighed. The determinations were easily completed in two hours.

King's College, London, September 1, 1886.

ON THE

PURPLE OF THE SOLAR SPECTRUM.

By M. CAMILLE KŒCHLIN.

IN the solar spectrum there are found only two simple colours, blue and yellow. The third is blended with the yellow and the blue to form on the one side the reds and on the other the violets. The purple is the red minus the yellow or the violet minus the blue, or again, the the spectrum without yellow or without blue. If we project upon the red of one spectrum the blue of a second spectrum, or the yellow of the latter upon the violet of the first, we obtain purple. We can restore the red or the violet by projecting respectively upon the purple the yellow or the blue of a third spectrum. If these superpositions are effected with reversed prisms so that the complementary colours reciprocally cover each over, the spectrum presents at each extremity a purple region with a yellowish-white interval.

If we gradually suppress the light of a spectrum at the purpled extremity the fading colours leave purple for a last trace.

Although the red tones of the spectrum become poorer in yellow, the further they remove from that colour they reach their extreme limit without displaying the purple in its characteristic purity. The yellow on one hand and the blue on the other share between themselves the purple of the prismatic spectrum, even to the last traces. It would not be the same in spectra without interruption of continuity, such as are shown by nacreous irisations, by soap-bubbles, crystals, supernumary rainbows, and the twilight illuminations of the clouds. If we establish a bare interval in a green ground we have the impression of purple, which is the colour complementary to green. Compound colours correspond to the simple colours, and inversely.

The purple colouration is very rare among mineral compounds. We shall mention only the ruby, the enamels of gold and of copper, and certain flames. In the vegetable kingdom purple is next in abundance to white and yellow. The roses, pinks, cinerarias, fuchsias, geraniums, present types of it in all intensities. Rose is dilute purple, not dilute red, which would give flesh-colours. Among dye-drugs we have magenta (salts of rosaniline), the red-woods, ammoniacal cochineal, the methylic eosines, xylidine red, pseudopurpurine, alizaramide, and, by right of antiquity, murexide or Tyrian purple. A curious fact in this assortment of colouring-matters is that none of them gives a fast purple. This problem would be of the greatest importance not merely in virtue of a beauty of shade surpassing all others, but because it would give the means of compounding by mixtures, reds more or less inclining to carmine, amaranths, and fast parmes, which cannot be obtained with reds containing yellow. In place of parmes it would be the industrial violet (of madder) which does not exist in the spectrum, because it represents a mixture of red and blue and not of purple and blue.

Purple being a simple colour will never be obtained by mixtures, any more than we can obtain a yellow by mixtures. We can arrive at purple only by eliminating the yellow from a red or the blue from a parme.

Red, properly speaking (the conventional scarlet) is more common among mineral products than is purple. It is the colour of vermillion, of mercuric iodide, of cochineal scarlets, coralline, xylidine, eosine, and of certain alizarine reds. If, in the vegetable kingdom, red flowers are not as common as purple flowers, there is one which may be considered as the type of reds, the field poppy (*Papaver Rhœas*). We may thus distinguish neutral reds from reds in which either purple or yellow predominates, such as cherry, fire, nacarat, orange, capucine, &c.

The solar spectrum contains the elements of all colouration, either by mixtures, by dilutions with white, or by extinction with black. In the latter case the colours containing blue retain their tint, whilst those on the yellow side are changed. Thus green, blue, and violet give what are called heavy greens, heavy blues, heavy violets, whilst yellow, orange, red, and purple cannot be deepened, but become olive, brown, garnet, or amaranth.—*Comptes Rendus*, ciii., p. 432.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.*

By J. D. VAN DER PLAATS.

(Continued from p. 164.)

XXI. *Synthesis of Nitrate of Lead*, a 303.

THE atomic weight of lead formed the subject of several researches of Berzelius. This illustrious man, "whose analytical exactitude has never been surpassed, if even ever equalled, no matter by whom" (Stas, *a* 208) found, while reducing oxide of lead by hydrogen, values varying from 207·16 to 207·02, the mean being 207·1. M. Stas has sacrificed an enormous amount of time to preparing pure lead, but it always contained 5-100,000ths of potassium and sodium, with traces of copper and iron. These impurities, forming alkaline nitrates, augment the weight of the nitrate of lead by about 0·007 grms. per 100 grms. of lead. Further, there exist doubts as to the degree of desiccation of the salt, which is decomposed at 195°, and does not lose all its water even at 140°.

M. Stas has made two series of syntheses; in the first the nitrate was dried in a current of air; in the second the drying operation was conducted *in vacuo*. I have availed myself of the results of the latter series.

Lead.	Nitrate of Lead.	Pb : PbN_2O_6=100.
103·000	164·773	159·9738
140·6887	225·0674	159·9755
110·2672	176·408	159·9860*M
141·9927	227·1527	159·9749
148·616	237·702 (?)	159·9438* (?)
124·348	198·924	159·9736
	Mean of the first series	159·9713*
100·000	159·970	159·970
200·000	319·928	159·964
250·000	399·8975	159·959 *m*
250·000	399·914	159·9656
	Mean of the second series	159·9646
	Log =	2·2040239
	Mean of the ten estimations	159·9686
	Log. =	2·2040347

XXII. *Synthesis of Sulphate of Lead*, a 308.

The impurities of the lead diminish the relation, whilst the air condensed on the sulphate might possibly augment it. M. Stas declares "that there is no estimation which offers so many difficulties and uncertainties."

Lead.	Sulphate of Lead.	Pb : $PbSO_4$=100.
141·9925	207·9388	146·4435 M
148·616*	217·6141	146·4270
100·000	146·419	146·419 *m*
200·000	292·864	146·432
250·000	366·0525	146·421
250·000	366·0575	146·423
	Mean	146·4276
	Log. =	2·1656230

It was the nitrates of experiments 4, 5, 7, 8, 9, and 10 that were turned into sulphates.

* *Ann. Chim. Phys.*, 6th Series, vol. vii., April, 1886.

We shall deduce from these twenty-two proportional relations the atomic weights of ten simple bodies.

We will take as the basis, oxygen, O = 16.

A. *Atomic Weight of Silver.*

If we take the relations I. and II.—

$$Ag_2 : Ag_2S = 1 : a$$
$$\text{and } Ag_2SO_4 : Ag_2 = 1 : b, \text{ then}$$
$$Ag = \frac{32}{\frac{1}{b} - a} \text{ and } S = \frac{a - 1}{\frac{1}{b} - a} 64$$

These two values are *independent* of all other atomic weights.

Again, let us take the relations III. and IV.—

$$Ag : AgCl = 1 : c$$
$$\text{and } AgClO_3 : AgCl = 1 : d, \text{ then}$$
$$Ag = \frac{d}{1 - d} \cdot \frac{48}{c} \text{ and } Cl = \frac{d}{1 - d} \times \frac{c - 1}{c} 48$$

In the same manner we can calculate the relations V. and VI., VII. and VIII. A fifth value for silver is deduced from IX. and X.

$$\text{If } KClO_3 : KCl = 1 : e, \text{ and}$$
$$Ag : KCl = 1 : f, \text{ then we have}$$
$$Ag = \frac{e}{1 - e} \cdot \frac{48}{f}$$

We can obtain the lowest values for the atomic weight of silver by combining the minima of the relations of a and b, the maximum of c, and the minimum of d, &c. The maxima of a and b, the minimum of c, and the maximum of d give the highest values. By combining the averages we deduce the most probable figure.

In the following table I give the extreme and the average values. The variation between the extremes gives a better idea of the exactitude of the mean than the calculation of least squares. The numbers in parenthesis have been calculated with the mean of the relations of III., IX., and XXI., which is less probable for the reasons stated above. (See Table A).

If we call *uncertainty* that quantity by which the true value *might* differ from that which we accept as correct, whilst a value more removed might be considered as very improbable, I think we must admit the following :—

	Degree of uncertainty.
Ag = 107·930..	0·01

which signifies that, according to the present state of science, the atomic weight of silver cannot be higher than 107·94 nor lower than 107·92, whilst the most probable value is 107·93.

B. *Atomic Weights of Chlorine, Bromine, Iodine, and Sulphur.*

We have already indicated the method adopted for calculating an independent value of the atomic weight of each of these simple bodies. We obtain two new values by admitting that Ag = 107·93. (See Table B).

Which leads me to admit the following :—

	Uncertainty.
Cl = 35·456	0·005
Br = 79·955	0·01
I = 126·857	0·01
S = 32·06	0·01

(To be continued).

TABLE A.

Silver.

Atomic Weight. From the Relations of the Tables.	Atomic Weight. From the Syntheses and Analyses of	Maximum.	Minimum.	Mean.
I. II.	Ag_2S and Ag_2SO_4	107·9771	107·8690	107·9269*
III. IV.	AgCl and $AgClO_3$	107·9492	107·9271	107·9345* [107·9387]
V. VI.	AgBr and $AgBrO_3$	107·9440	107·9002	107·9221
VII. VIII.	AgI and $AgIO_3$	107·9539	107·9112	107·9313*
IX. X.	$KClO_3$ and Ag : KCl	107·9520	107·8820	107·9330 [107·9150]

Mean of the five independent figures 107·9296

TABLE B.

Chlorine.

III. IV.	Independent value.	35·4537	35·4519	35·45645* [35·45225]
III.	AgCl	35·4547	35·4456	35·4550 [35·4494]
IV.	$AgClO_3$	35·4711	35·4508	35·46095
	Bromine.			
V. VI.	Independent value.	79·9629	79·9366	79·9497*
V.	AgBr	79·9586	79·9526	79·9556
VI.	$AgBrO_3$	79·9769	79·9068	79·9418
	Iodine.			
VII. VIII.	Independent value.	126·8759	126·8423	126·8572
VII.	AgI	126·8645	126·8470	126·8557
VIII.	$AgIO_3$	126·8990	126·8235	126·8585
	Sulphur.			
I. II.	Independent value.	32·0781	32·0347	32·0588*
I.	Ag_2S	32·0641	32·0528	32·0597
II.	Ag_2SO_4	32·0891	32·0362	32·0616

ANALYSIS OF SILICATES IN CONNECTION WITH BLOWPIPE DETERMINATIONS.

By W. M. HUTCHINGS.

All mineralogists who are accustomed to make use of the blowpipe for analysis are painfully aware that, as regards the largest of all the classes of minerals, the silicates, that very valuable instrument and its accessories can only suffice for a more or less satisfactory preliminary examination, and that for a complete qualitative knowledge of the composition of the specimens the "wet way" has to be called in. This is always comparatively tedious and troublesome, and specially so in the case of minerals which are not capable of being directly decomposed by hydrochloric acid. It is, of course, a very neat and comparatively speedy operation to fuse the mineral with sodium carbonate in a charcoal mortar, after wrapping the mixture in "soda-paper," as directed in Plattner's book; and the following wet analysis does not take a long time, but it seemed to me that it could be still further improved, both as to the time required and as to the number of "wet" operations involved. This is of im-importance, because the object of all chemists who practise blowpipe-work should be to get as far as they possibly can with "dry" operations, and so reduce as much as possible the quantity of chemicals in liquid form which must find a place in the portable laboratory.

Having recently had occasion to rapidly examine several silicates, I have tried another method, which has proved so satisfactory that I think it worth while to recommend it to others.

I decompose the silicate by means of ammonium fluoride, and fuse the fluoride residue with sodium carbonate, thus removing the silica and separating the bases into two groups rapidly, and entirely with "dry" reagents.

For the purpose in view, namely, mineral determinations, our attention is only required to be given to a very few constituents. Alkali we determine by flame-colouration. Also, before taking to the wet way, our blowpipe tests have shown us what metallic oxides are present. All we need consider in our wet analysis will be the alkaline earths and alumina, approximately their relative amounts, and that of the oxides of iron to alumina in some cases.

The fusion of the fluoride residue with sodium carbonate and solution of the fused mass in water gives us alumina in solution, leaving alkaline earths and oxide of iron undissolved. The separation, properly carried out, is very perfect, whether we have relatively much or little alumina to deal with. After filtration the solution is of course acidified, boiled, and alumina precipitated by ammonia. The insoluble portion in the filter is washed, and dissolved in a few drops of acid into a test-tube. If barium or strontium are suspected in the mineral, a drop of H_2SO_4 will prove their presence and remove them. The iron is then precipitated by ammonia, and tests applied for Ca and Mg as usual.

We by this method avoid the tedious solution of the mineral (after fusion with soda) in HCl, and the trouble-some evaporation to dryness and removal of the SiO_2. We also escape that most unpleasant operation, separation of Al_2O_3 and Fe_2O_3 by caustic alkali. I think anybody who makes trial of this plan will speedily see a great gain in time and convenience, as well as neatness.

About 50 to 75 m.grms. of very finely powdered mineral should be taken. I use a little bone spoon which when full holds about 150 m.grms. of an average silicate, and I take this half full of mineral powder, which is placed in the bottom of the small platinum spoon. The mineral is then covered with three heaped-up bone spoons of ammonium fluoride (say seven to eight times the weight of the mineral), which just fills the platinum spoon. This is then held over a small spirit-flame. The ammonium fluoride at once melts in its water of crystallisation, and the mineral should be stirred up with a platinum wire. It is rapidly attacked, and a syrup is formed in the spoon, which is then evaporated down. Very little loss takes place from spirting of the mass. When dryness is nearly reached care must be taken, and the last portion of the operation carried on at low heat (barely incipient redness at the finish), as in some cases, where much alkali is present, the fluorides fuse easily and stick to the spoon. The final mass should be a loose crust which leaves the spoon easily. This operation takes about eight minutes, and should not be hurried, as proper time must be allowed for the action of the melted ammonium fluoride before it is driven off. It is well to use rather more than less of the reagent.

The residual fluorides are removed to the agate mortar, and well mixed with two full spoons of calcined sodium carbonate (say four to five times the weight of original mineral), and made to a paste with drop of distilled water. This paste is taken on loop of platinum wire and fused in strong blowpipe-flame, the beads being knocked off while liquid into a capsule, or on to the aluminium plate placed under the lamp. About four good large beads will result. The fusion must be at a very strong heat, and be kept up till some little time after all effervescence ceases in the bead. The mixing with sodium carbonate and fusion take eight to ten minutes.

The beads are then broken in the steel mortar, powdered in agate mortar, and the powder put into small test-tube and boiled with distilled water. Solution is very rapid, and so also is filtration. Subsequent operations need no further description. The water used is only a small quantity. Three little filters are required.

The whole analysis takes barely half an hour up to the precipitation of calcium oxalate, when of course the necessary time must be allowed before proceeding to test for magnesia. Thus caustic potash is no longer required, much less acid is used, and much less ammonia. Four small test-tubes are used supposing Ba and Sr absent, and their occurrence is rare in mineral silicates. I myself prefer this method even for silicates decomposable direct by acid.

I have given the above in some detail for the benefit of such mineralogists as are not specially chemists, and so may not be acquainted with the use of ammonium fluoride. This reagent must be pure of course, viz., it must leave no residue whatever when evaporated off platinum. It can be kept any length of time in glass bottles coated with paraffin wax.

While on the subject of blowpipe analysis perhaps I may be permitted to allude to a reagent I myself suggested several years ago, viz., the mixture of cuprous iodide and sulphur in place of Von Kobell's mixture of potassium iodide and sulphur.

The use of this mixture in connection with aluminium plate has proved itself most valuable as a delicate test for small amounts of Bi and Pb. What I wish to say is, principally, that when I first used it I had some doubts as to its retaining its efficiency for a long time. I have recently opened a case containing some reagents packed up for many years during my absence abroad, and I find some of the iodide mixture as good as the day I prepared it.

The same applies to some "Turner's flux" (for testing for boric acid in minerals) made many years ago. Dr. Iles, in writing of his use of glycerin as a test for boric acid (Chemical News, July 28th, 1877), said that Turner's reagent would not keep. It keeps perfectly if well stoppered, and if prepared as dry as possible. The glycerin test is a very neat and effective one. There is nothing to choose between it and Turner's test as regards delicacy. But glycerin is a nasty sticky mess to carry in one's reagent-case compared with Turner's reagent! There is, however, one case in which glycerin can be used where Turner's test is not applicable, viz., in the presence of copper. Using Turner's mixture, a volatile copper fluoride is formed which colours the flame strongly

green. Glycerin does not produce any such effect, of course, on copper compounds, and the boric combination volatilised is very distinct if properly introduced into the flame. Should the substance contain so much copper that it gives a green colour *without* glycerin, a little sodium carbonate should be added to the paste, sufficient to enable the Na colouration to overpower the copper-green. The boron-green will appear quite distinctly in spite of the sodium. A similar use of sodium-flame to cover the copper, with Turner's test, is not applicable, because the copper fluoride is quite as volatile as the boric combination, and appears, like that, in spite of sodium.

Chester, September 25, 1886.

ON THE

SEPARATION OF SILICA IN THE ESTIMATION OF MANGANESE IN PIG-IRON,

AND ON THE

ESTIMATION OF PHOSPHORUS IN PIG-IRON AND STEEL.

By L. MANDEVILLE DEANE, F.C.S.,
Sir W. G. Armstrong, Mitchell, and Co.

Estimation of Manganese.

THE methods commonly in use for the estimation of manganese in pig-iron are no doubt well known to most analysts who are engaged in iron and steel work, but I believe it is not generally as well known that the ordinary process requires modification where it is applied in the analysis of pig containing above 2 per cent of silicon, as is generally the case with hematite iron, in which as high a percentage as 4 per cent is often found.

Having had several years' experience in the analysis of the above-named substance, I have generally found that a very appreciable quantity of silica is apt to escape filtration, and is finally precipitated and weighed with the oxide of manganese, thus rendering the manganese estimation erroneous.

In lately analysing a sample of pig-iron containing 2·106 per cent of silicon, I found that 0·240 per cent of silica was precipitated with the oxide of manganese, thus making a considerable error in the determination of the manganese.

The process I made use of was as follows:—

Two grms. of the substance are dissolved in a flask by the addition of 1 fluid oz. of hydrochloric acid; when solution is effected ½ a fluid oz. of nitric acid is added, and the heating continued until the red fumes have ceased to be evolved.

The solution is then poured into a large beaker, and largely diluted with boiling water; solid ammonium carbonate is now added, in small quantities at a time, until a deep mahogany colour is produced (the liquid being stirred round during the addition of the ammonium salt). As soon as this has occurred ammonium carbonate solution is dropped in until a slight permanent precipitate is obtained; after the addition of 4 fluid ozs. of strong ammonium acetate solution and stirring up, the beaker is heated until the contents boil briskly.

The beaker is then wrapped in a piece of felt, to prevent loss of heat as much as possible, and allowed to stand until the precipitated basic acetate of iron has settled. The solution is filtered through a large English filter-paper (glass rods being hung on the inside of the funnel to ensure greater rapidity of filtration); the precipitate is washed three times by decantation, which is easily done as the acetate settles very readily: at the third and last washing both the precipitate and solution are poured on the filter.

The large solution is now evaporated down in a porcelain basin to as small a bulk as possible; it is then filtered through a Swedish filter, and the filtrate collected in an ordinary triangular flask; after the addition of bromine to slight supersaturation, the solution is allowed to stand for an hour or so.

Ammonium hydrate is next added with caution to excess, and the flask boiled; the hydrated oxide of manganese is collected on a washed Swedish filter, and washed once with hot water.

Both the filter and precipitate are dried; then ignited in a weighed platinum crucible, in a Fletcher's muffle-furnace, for about three-quarters of an hour.

On weighing the resultant precipitate, which should have consisted wholly of manganoso-manganic oxide, I found that it gave a higher percentage of manganese (viz., 1·490) than my experience led me to anticipate could have been present in the metal; I therefore concluded that there must have been some other substance mixed with the oxide, which substance I inferred to be silica.

I therefore brushed the oxide of manganese, &c., out of the crucible into a small beaker, and effected solution of the manganese by heating with a little hydrochloric acid; the insoluble residue (which proved to be silica) was collected on a washed Swedish filter, and washed three times with hot water, and the filter and silica ignited in a platinum crucible.

On weighing I obtained the following results:—

Silica = 0·240 per cent.
Manganese weighed and calculated (without subtracting the silica) = 1·490 per cent.
Manganese (silica being subtracted) = 1·318 per cent.
Difference between the two results = 0·172 per cent.

The second result therefore gives the correct amount of manganese in the pig-iron in question.

I proved that the large quantity of silica (which was precipitated with the oxide of manganese) did not come from the reagents used in the determination, by taking a steel containing 0·526 per cent of manganese and 0·138 per cent of silicon (a Siemens-Martin steel which was rather high in silicon). I found, in case of the above steel, that only 0·015 per cent of silica was precipitated with the manganese (this might proceed from an unavoidable amount present in the reagents, or from the glass vessels themselves): this would only make the result too high by 0·011 per cent—an insignificant weight in the determination of manganese.

Estimation of Phosphorus.

I have had a large experience in the estimation of the above impurity.

Having found in this determination that when the precipitation of the phosphorus was effected in a strong nitric acid solution and filtered in this condition, the precipitated ammonio-phospho-molybdate had a great tendency to pass partially through the filter, I proceeded as follows:—

Before adding the ammonium molybdate I diluted the nitric acid solution with cold water to about one-third the capacity of the beaker used. On filtering I found that a perfectly clear filtrate was invariably the result. I use the following process for the estimation of phosphorus:—

One grm. of the substance is dissolved in 20 c.c. of nitric acid (1·2 sp. gr.), and the solution taken to dryness; the dry residue is re-dissolved in hydrochloric acid, and the liquid again evaporated to complete dryness.

Solution is now effected in hydrochloric acid, and the silica separated by filtration.

The solution is then taken down nearly to dryness (until a skin has formed on its surface), a few drops of nitric acid are added, and heating continued until the red fumes have escaped. The solution, after cooling, is diluted with cold water to about one-third the capacity of the beaker, and, after the addition of 1 fluid oz. of ammonium molybdate solution and shaking up, the beaker is allowed to stand until the precipitation of the phosphorus

complete: this usually takes place in from one to three hours (very often in the former space of time).

As much as possible of the clear supernatant solution is poured off, and the precipitate is collected on a Swedish filter (which has been previously dried and weighed in a small glass weighing-bottle, provided with a glass stopper), and washed six times with cold water containing 1 per cent of nitric acid. The precipitate and filter are dried in a water oven for three or four hours, and weighed when cool.

The result of this weighing—the weight of the bottle and filter being subtracted—gives the amount of dried ammonio-phospho-molybdate, which is then calculated into phosphorus.

INDEXING CHEMICAL LITERATURE.*

REPORT OF THE COMMITTEE.

IN presenting their Fourth Annual Report the Committee is pleased to record gratifying evidences of a wide and growing interest in the bibliographical work which it is designed to encourage and aid. During the past year the correspondence conducted by the Chairman has been three-fold greater than in any previous year, and the subjects referred to the Committee have increased in diversity much beyond expectation, until they include important questions in general chemical bibliography. Some of these questions pertain to matters which require for their solution an authority which the Committee is unwilling to claim or assume; such, for instance, is the question of uniformity in abbreviations of chemical periodicals, the desirability of which is admitted, while the feasibility of devising a list of abbreviations which would be regarded as authoritative is doubtful. One of the Committee discusses this subject in a communication to the Chemical Section, appended to this Report, and to this we relegate further consideration.

Indexes Published.

"Bibliography of Petroleum," by Prof. S. F. Peckham. Report on the Production, Technology, and Uses of Petroleum and its Products. Report of the Tenth Census of the United States, vol. x., 1884, 4to., pp. 281-301. [A comprehensive bibliography of Bitumen and its related subjects.]

"Bibliography of the Metal Iridium," by Nelson W. Perry, in Prof. W. L. Dudley's paper on Iridium published in "Mineral Resources of the United States," calendar years 1883 and 1884. Washington, 1885. 8vo.

"An Index to the Literature of Uranium, 1789 to 1885," by H. Carrington Bolton. *Smithsonian Report for* 1885. Washington, 1885. 36 pp., 8vo.

It is almost superfluous to call attention to the following superb work, yet for sake of completeness it may be here recorded:—

"Melting- and Boiling-Point Tables." Physico-Chemical Constants, by Thomas Carnelley. Vol. i., London, 1885. 350 pp., royal 4to. [To be completed in two volumes comprising about 50,000 melting- and boiling-point data.]

Reports of Progress.

Prof. William Ripley Nichols has done a great deal of work on the Index to Carbon-Monoxide, but defers printing another year.

Prof. Charles E. Munroe reports he is ready to print a section of his extensive Index to the Literature of Explosives.

Prof. L. P. Kinnicutt is engaged on a Bibliography of Meteorites.

Dr. F. E. Engelhardt is compiling an Index to the Literature of Common Salt.

Projected Bibliographies.

Prof. F. W. Clarke has nearly ready for the press a new edition of his "Specific Gravity Tables," Constants of Nature, Part I. This edition will contain about twice as much matter as the original work, although melting- and boiling-points are omitted, these having been catalogued by Dr. Carnelley in the work above mentioned.

Profs. William Ripley Nichols and Lewis M. Norton are engaged on a "Dictionary of Chemical Synonymes," which will prove a valuable contribution to chemical bibliography and of practical utility to chemists.

Mr. S. P. Sharples, of Boston, informed the Committee in November, 1885, of his willingness to complete an "Index to the Literature of Milk Analysis" which he had compiled several years before; and a few weeks later Mr. Clement W. Andrews, of the Massachusetts Institute of Technology, notified the Committee of a similar undertaking which he proposed perfecting and bringing down to date. These two gentlemen were at once put into communication, and a mutual understanding has been reached whereby useless duplication will be avoided.

Prof. Stephen F. Peckham, of Providence, R.I., whose voluminous "Bibliography of Petroleum" is noticed above, is engaged on a continuation of the work, which he plans to bring down to 1890.

Prof. William H. Seaman, of the U.S. Patent Office, calls attention to the important literature of Chemistry found in Patent Specifications, and proposes to compile an "Index to American Chemical Patents," for which undertaking he has unusual facilities.

Prof. Erastus G. Smith, of Beloit, has begun an "Index to the Literature of Aluminium," a topic suggested by the Committee.

Mr. George F. Kunz, of Hoboken, is collecting and indexing works relating to "Gems and Precious Stones." His bibliography already numbers 2000 titles, and will treat of the subject in a comprehensive manner, including facts relating to the history, mining, cutting, uses, and literature of gems in all languages.

Mr. William Beer, late of the College of Physical Science, Newcastle-on-Tyne, availing himself of facilities afforded by the Library of the University of Michigan, is engaged on a "Bibliography of Scientific Bibliographies," the first part of which he intends soon to offer to the Committee; he has also in an advanced state a "Bibliography of Copper."

The Committee desires to record thanks to the American Association for the Advancement of Science for reprints of reports furnished free of charge, and also to the Smithsonian Institution, which gratuitously distributed the reports to chemists and others.

The Committee again appeals to chemists for support, and calls for volunteers to undertake indexes to special topics in chemical literature, especially the chemical elements. The Committee dictates no fixed plan, but leaves method and subject to authors; the Committee does not seek to control the productions further than to insure work of high merit and to guard the interests of the Smithsonian Institution, which has agreed to publish manuscripts endorsed by the Committee. Sample copies of Indexes and other information can be obtained by addressing the Chairman, care of the Smithsonian Institution.

H. CARRINGTON BOLTON, *Chairman.*
IRA REMSEN.
F. W. CLARKE.
ALEXIS A. JULIEN.

July, 1886.

NOTE.—Since writing the above the death of Prof. Wm Ripley Nichols is announced. Absence from the country has prevented Prof. Albert R. Leeds from signing the above Report.

* Read before the Chemical Section of the American Association for the Advancement of Science, August, 1886.

NOTICES OF BOOKS.

President's Address. By Professor Liversidge, F.R.S. Delivered to the Royal Society of New South Wales, May 5, 1886.

This address contains much matter of very general interest. The position of the Society appears to be scarcely so desirable as the friends of science might wish. The number of Fellows does not increase and the debt on the Society's house is still not wiped out. Until this is done the Society cannot itself publish its annual volume of transactions. Important additions have been made to the library, the Council wisely turning its attention to obtaining complete sets of the Transactions of learned Societies, which are day by day becoming more rare and difficult to consult. During the past year only twelve papers have been read at the Society's meetings, two of which, moreover, were devoted to flying-machines! Three papers, however, have been read before the Microscopical and eighteen before the Medical Section.

Professor Liversidge very naturally complains that the number of original papers contributed to the Society is so small. Out of nearly 500 members, only 35 have contributed papers, and of these the majority have been furnished by some seven or eight individuals. He declares that "up to the present but little original work has been done in working out the chemistry of our mineral and vegetable products, and really but very little in many branches of biology." To account for this neglect he states that "There are but few men of leisure in the Colonies, and still fewer of learned leisure." Yet we have heard the complaint raised that in Australia there was nothing for young men of wealthy families to do, and that, consequently, many were drifting into dissipation!

There prevails, it would seem, a difficulty in obtaining gums and resins *true to name*, and this the President regards rightly as an additional proof of the ignorance (or indifference) which exists with regard to the natural products of the colony.

The Society offers its medal and a premium of £25 for original researches on a number of interesting questions. The papers due for May 1 this year included investigations on the chemistry of the Australian gums and resins, on the tin deposits of New South Wales, and on the iron ore deposits of New South Wales. The following are due on or before May 1, 1887. "On the Silver Deposits of New South Wales" and on "Origin and Occurrence of Gold-bearing Veins and associated Minerals." An investigation on the "Chemical Composition of the Products from the Kerosene Shale of New South Wales" is required by May 1, 1888.

An unpleasant fact here put on record is that the Biological Laboratory at Watson's Bay—a true aquarium—has been closed! Only one naturalist, and he a foreigner, has made use of the establishment!

This naturally leads Professor Liversidge to turn to the question of scientific training. He quotes largely and appositely from Prof. Huxley and Mr. Herbert Spencer, and he adds the remark that in the ordinary classical and mathematical education the student's "powers of observation and of reasoning from such observations are entirely neglected and undeveloped." We need not, surely, express our entire concurrence. A denunciation of "cram" or of word-knowledge as distinguished from thing-knowledge naturally follows. But how is it that whilst "cram" is attacked on every hand, and whilst scarcely a voice is raised in its defence, it still maintains its ground?

The late meeting of the British Association at Montreal naturally suggests the prospect of future meetings in other colonies, and Australia, from its size and its importance, naturally puts in the first claim. That Professor Liversidge, like ourselves, holds such a step to be exceedingly desirable is evident. But he sees, in the way of realising the project, certain grave practical difficulties which it it would be idle to ignore. These resolve themselves substantially into the two considerations of time and money. He says:—"The necessary travelling expenses would considerably exceed the whole year's income of many—for the pursuit of Science is not a lucrative one, and as a rule its followers are poor." The expenditure of time, too, would be very important. The visit to Montreal was managed by the majority of the 800 to 900 who entered their names for the meeting in a month or six weeks. But a voyage to Sydney by the shortest route takes about six weeks, and if we allow a week only for the actual business of the Association and a fortnight for visiting places of interest in Australia, we shall have a total little short of four months! How many professors, editors of scientific journals, officials of museums, consulting chemists, electricians, &c., could afford such a holiday? Hence the speaker held it doubtful whether above 50 members of the Association would put in an appearance at Sydney. He therefore proposes, as an intermediate step, the formation of an Australian Association for the Advancement of Science, the first meeting of which might be held on the hundredth anniversary of the colony, when, he adds, "there will probably be an International Exhibition to celebrate that event." We can only hope that some more patriotic and useful method of celebrating the event may be devised.

Returning from this brief digression we notice that Prof. Liversidge proposes the division of the Association into ten sections. Most of these coincide with the sections of the parent Association, Section I (Literature and the Fine Arts), is an innovation, and, as far as we can judge from the career of the so-called "Literary and Philosophical" Societies of England, one not to be recommended. Among a people, educated as the British race has been, literature, wherever introduced, generally secures the lion's share of attention and means. Section F (Economic Science and Statistics) is a dangerous member, from its tendency to degenerate into politics. Hence its excision in the British Association has been repeatedly mooted, and is doubtless a mere question of time. If retained it might very well be included under J (Social Science). In all other respects we are most favourably impressed with the outline scheme of the Australian Association, as suggested by Prof. Liversidge, and hope that it may be carried into execution.

On the Spectra of the Gases and Vapours Evolved on Heating Iron and other Metals. By John Parry, F.C.S. Pontypool: Hughes and Sons. Printed for private circulation.

In the introduction to this book, some of Professor Graham's results are commented upon, and it is stated that in the course of a research on the quantity and kind of gases evolved on heating iron and steel *in vacuo*, results very different from Graham's have been arrived at, and conclusions are formed of great practical importance to iron and steel makers, namely, that the presence of gases in iron and steel is very deleterious, and should be prevented if possible.

The pages following are a collection of notes and papers on gases evolved by various metals, principally iron, and a description is given of the apparatus used and its general arrangement, by which means a number of photographs of spectra were taken.

In the paper on the gases contained in coke the results of a number of experiments are given, and the author has found, contrary to the general opinion, that coal persistently retains hydrogen, even at very high temperatures.

The latter part of the book consists of a collection of 58 plates of photographs of spectra, with a short note describing each.

Chemists will appreciate the excellent collection of photographs at the end of the work, which makes this a

most valuable contribution to our knowledge of spectra, and the author deserves great praise for the careful compilation of the same.

CORRESPONDENCE.

MAGENTA *v.* FUCHSINE.

To the Editor of the Chemical News.

Sir,—Mr. Allen might learn from the epithets "kakophonous" and "un-English," which I applied in my last letter to the term "fuchsine," that I am very far from retiring from my original position. The combination of letters "chs" is so unsuited to Englishmen that most horticulturists have now converted "fuchsia" into "fuschia," as better expressing its ordinary pronunciation. The terms "rose-colour," "cherry-colour," and "plum-colour" have become established by a convention of more than a century; but "fuchsia-colour" is not so recognised. Neither florists nor dyers understand by it any particular tone. One of the latter fraternity said, when questioned, that fuchsia-colour might mean anything from a pale flesh to a deep purple. In most varieties, too, the calyx and the corolla differ, whilst even the latter is not self-coloured, and changes its hues progressively from first opening until it falls. Hence I submit that Messrs. Renard were guilty of a twofold *bêtise* in applying to rosaniline hydrochlorate a name taken from such a flower. I for one shall certainly not encourage the use of a name which the practical sense of our countrymen has led them to reject.—I am, &c.,

Your Reviewer.

VEGETO-CHEMICAL CHANGES.

To the Editor of the Chemical News.

Sir,—From the frequency of the English mail delivery we now receive constant and regular supplies of the Chemical News: in the various numbers many descriptions of vegeto-chemical changes may be paralleled in New Zealand.

In the June number of the present year (Chemical News, vol. liii., p. 277) there is a note from Mr. Samuel Rideal "On the Blue Colouring-matter of Decaying Wood," in which it is stated that nitrogen takes no part in the production of the colour.

The following instance of the appearance of a very beautiful blue bears evidence of the presence of cyanogen:—My children shaped from a pukatea tree (*Atherosperma Novæ-Zealandæ*) a canoe, which was floated in an extemporised lake formed by the damming of a small stream. During the winter months no change in the colour of the water that occasionally leaked through the canoe was observed, but during the summer—when the water at a higher temperature had become surcharged with CO_2 from decaying vegetable matter—iron, which is so abundant in these volcanic soils, was dissolved, so that when the canoe was for any length of time filled with the water a beautiful deep blue colour was visible. After about two years the timber ceased to yield the same result.

A bushman, in occupying a new country, will select the neighbourhood of a pukatea as a fertile spot.

The Maoris make use of the bark of this tree as a nerve tonic. In the selection of a tree for stripping they always take one that has been exposed to the fullest effects of the sun's rays. I have succeeded in isolating an alkaloid from the bark in acicular crystals: a very small fragment placed on the tongue produced an intense bitter taste, which on passing away left a glow throughout the whole system that was felt for hours.

In a small case of preparations from our forest trees, sent to the Colonial Exhibition, there are some small bottles of an extract formed from the bark of the pukatea tree.—I am, &c.,

W. Irwin Grayling.

Egmont Village, New Plymouth, Taranaki,
August 6, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xv., Part 4.

Fluctuations of Carbonic Acid in the Air.—Prof. E. Wollny.—The author considers it highly probable that the quantities of carbonic acid produced by the industrial consumption of large quantities of fuel must produce a local augmentation of the proportion of this gas. The influence of putrefaction and decay seems to be only of subordinate importance. The ground-air is a productive source of carbonic acid. The air over fallow fields is richer in carbonic acid than that over land covered with vegetation. During the night the proportion of carbonic acid is greater than by day. The principal absorbents of carbonic acid are vegetation and the sea.

Processes of Oxidation and Reduction in the Soil effected by Microbia.—A. Müntz.—The author proves that the microbia are capable of oxidising or reducing certain haloid salts. The microbia of nitrification oxidise iodides to iodates and bromides to bromates. The experiments with chlorides have yielded no decisive results. In the absence of air potassium iodate was reduced to potassium iodide, and similar results were obtained with potassium bromate and chlorate.

Researches on the Capacity of the Soil for Water.—Prof. E. Wollny.—The conditions which have the greatest influence upon the capacity of a soil for water are the fineness of its constituents, their porosity, and the manner of their arrangement. The fertility of a soil cannot be determined by its capacity for water alone.

Experiments on the Cultivation of Beets in Posen.—Haake and Tschuschko.—Not susceptible of useful abridgment.

Ammonia or Chili Saltpetre.—Prof. W. Märcker.—In experiments on barley the effect, as compared with that obtained by a corresponding quantity of soda-saltpetre, was as 3 : 3·74 for the grain, and as 3 : 6·04 for the straw. Sulphate of ammonia does not give satisfactory results if used along with farm-yard manure. When nitrogen in sulphate of ammonia is used in place of nitrogen in soda-saltpetre, the quantity must be increased as 3 : 4 or at least 3 : 3·5.

Manurial Value of Bracken (Pteris aquilina).—R. Hornberger.—The value of the dried bracken from one hectare of land may be valued at 31s. 6d.

Should Commercial Manures be dug in or scattered over the Surface.—Jul. van der Berghe.—The best result was obtained when the manures were dug in to the depth of 22 centimetres.

The Essential Chemical Elements of Plants.—T. Jamieson.—From the Chemical News.

Loss of Oxygen sustained by Plants in the Microspectrum.—N. Pringsheim.—There is no relation between the emission of oxygen and the absorption of light in the chlorophyll. The red rays between B and C do not especially subserve the decomposition of carbonic acid.

Oxalic Acid in the Vegetable World.—Berthelot and André.—From the *Comptes Rendus*,

Action of Chlorophyll and Carbonic Acid outside the Vegetable Cell.—P. Regnard.—From the *Comptes Rendus.*

Respiration of Leaves in Darkness and the Carbonic Acid retained by Leaves.—Dehérain and Maquenne.—From the *Comptes Rendus.*

Effect of Saline Solutions upon the Germination of the Seeds of Certain Indigenous Crops.—M. Jarius. Weak solutions of the salts used in agriculture, from 0·4 to 1 per cent, favour germination and subsequent development, whilst solutions containing 2 per cent depress both.

Part ascribed to the Living Tissues of Wood in the rising of the Sap.—J. Vesque.—From the *Comptes Rendus.*

Exsiccation of Plants in Aqueous Saline Solutions.—A. Levallois.—From the *Comptes Rendus.*

Presence of Methylic Alcohol in the Products of the Distillation of Plants with Water.—Maquenne.—From the *Comptes Rendus.*

Composition of Capsicum Annum,—F. Strohmer.—Analysis of the entire fruit, of the seeds, and of the husks.

Valuation of American Red Clover.—Dr. Troschke.—The composition of American clover does not greatly differ from that of Silesian and Italian clover.

Experiments on the Cultural Value of Different Kinds of Oats.—O. Bessler and Prof. M. Maercker.—The results are given in the form of tables.

Preparation of Factitious Fatty Cheeses.—Dr. v. Klenze.—Rich cheeses of good quality cannot be produced by the addition of foreign fats.

Influence of Sunlight on the Vitality of Microbia.—E. Duclaux.—From the *Comptes Rendus.*

Fermentation-Products of the White Grapes of the Charente.—Ch. Ordonneau.—From the *Comptes Rendus.*

Justus Liebig's Annalen der Chemie,
Vol. ccxxxiv., Part 2.

Communications from the Chemical Laboratory of the University of Jena.—These consist of memoirs by Dr. A. Hand on certain benzol derivatives, and by Dr. Ad. Isbert on acetacetic ether and certain of its derivatives. The former of these papers treats of the so-called "fourth" monobromphenol, of the diazo-compounds, and of the question of metamerism in benzol. Dr. Isbert discusses the action of alcoholates upon acetacetic ether, the amide of ethyl-acetacetic ether soluble in water, the behaviour of phosphorus pentachloride with ethyl-acetacetic ether and with the corresponding methyl-compound, the action of sodium ethylate upon mono-chlor-ethyl and methyl-acetacetic ethers, and the decomposition of ethoxyl-alkyl-acetacetic ether by sodium hydroxide.

Investigations on the Glycidic Acids.—P. Melikoff.—The author concludes that although the glycidic acids belong to the saturated compounds they possess the property of direct addition. The energy of hydratation decreases with the increase of the molecular weight. Isomeric acids vary in their capacity of hydration, which depends on their constitution. Those acids in which oxygen is combined with a tertiary atom of carbon possess a relatively greater energy of hydratation. The haloid acids combine as energetically with the higher as with the lower members of the series. The elements of ammonia combine with the glycidic acids, forming amido-oxyacids.

Communications from the Chemical Laboratory of the University of Geneva.—These comprise a paper by L. Gresly on the reduction and condensation of the homologues of benzoyl-benzoic acid, and a notice, by the same author, on the formation of triphenyl-methan-carbonic acid from phenyl-phthalide.

On Lactucerine.—O. Hesse.—The author describes two compounds, α- and β-lactucerol, which he obtains from lactucerine.

On Pseudomorphine.—O. Hesse.—The author describes some reactions by which pseudomorphine and morphine are distinguished. Morphine dissolves in pure strong sulphuric acid with a faint reddish colour. Pseudomorphine dissolves at first colourless, but the solution soon becomes yellowish and then reddish. If the acid contains a very little ferric oxide morphine gives a reddish solution, but pseudomorphine a fine blue, which soon turns an intense violet and finally a brownish green. If morphine is mixed with an equal weight of cane-sugar it dissolves in sulphuric acid (pure or containing ferric oxide) with a violet-red colour. Pseudomorphine under the same circumstances yields, with pure sulphuric acid, an intense dark green, turning olive. If the acid contains ferric oxide the colour is at first a splendid blue, turning subsequently to an intense dark green.

Part 3.

Specific Heat of Homologous Series of Liquid Carbon Compounds.—Robert Schiff.—The author's results are given in the form of tables.

Evaporation-Heats of Homologous Carbon Compounds.—R. Schiff.—This memoir, which, like the foregoing, requires the accompanying figures, does not admit of useful abstraction.

On the Carbohydrates.—O. Wallach.—The author has examined a carbohydrate occurring in the rhizomes of the sweet-flag (*Iris pseudacorus*). It is more powerfully lævo-rotatory than inuline. It does not reduce Fehling's solution, but is rapidly converted into sugar by dilute acids. It is much more soluble in cold water than inuline, and in the sections of the rhizomes it has not been found practicable to produce the double refractive sphero-crystals so characteristic of inuline. Hence the author concludes that this product is not identical with inuline, in spite of many points of resemblance.

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THE CHEMICAL NEWS.

Vol. LIV. No. 1402.

DISSOCIATION AND CONTACT-ACTION.*

By the Rev. A. IRVING, B.Sc., BA., of Wellington College.

In a letter which appeared in *Nature*, on the 25th of March last, the author referred to some recently-published work of M. Konovaloff on Contact-action Phenomena, and to the suggestion thrown out by that gentleman that the bombardment of the molecules on the solid matter might cause a transformation in part of their kinetic energy into intramolecular work, tending to bring about dissociation of the molecules. Getting no reply to his request for information as to any previously-published work on this subject, and having found that one or two eminent chemists to whom he has mentioned the subject took a favourable view of the theory, which he has for some years past pointed out to his more advanced pupils as probably the true explanation of the experimental results observed, when, under the influence of heated spongy platinum or platinised asbestos, or other porous or finely-divided bodies,† combinations are brought about with the intervention of contact-action at much lower temperatures than are required without such contact-action, the author has ventured to bring the subject up for discussion in this Section.

Some of the most familiar examples of this kind of action are the following:—

(1.) The oxidation of ammonia, and of SO_2 in the presence of an excess of O_2.

(2.) The conversion of nitric oxide into NH_3 and H_2O in the presence of an excess of H_2.

(3.) The direct combination of mixtures of H_2 and Br_2, and of H_2 and I_2 respectively.

(4.) The oxidation of NH_3 gas, and of the vapours of alcohol and ether, by atmospheric oxygen in contact with a glowing coil of platinum-wire, or of a heated glass rod.

Of the explanations of these and similar phenomena which the author has met with, the following require a passing notice:—

1. The antecedent formation of a hydride with the hot metal, as when H_2 is passed over red-hot palladium; or the absorption of H_2, which is known to occur in the case of red-hot platinum to the extent of 3·8 times its own volume (Roscoe and Schorlemmer, II., ii., p. 397). This may explain the rekindling of a Bunsen gas-jet by a heated mass of spongy platinum, or even by heated platinum-foil, on account of the large quantity of free H_2 present in coal-gas, but it manifestly cannot apply to such instances as the oxidation of ammonia or sulphur dioxide by contact-action, and of course fails to apply to any case in which some other porous body is substituted for platinum.

2. Oxygen, it is well known, is condensed on the surface of cold platinum to such a remarkable extent that a large coil of platinum-foil, after considerable exposure to the air, may be buoyed up, so as to float in water, by the bubbles of oxygen which collect on its surface under the exhausted receiver of an air-pump. This condensation of O_2 on the surface of cold platinum is the probable cause of that increased activity which enables it to act spontaneously upon the jet of hydrogen in Döbereiner's lamp; but it fails to explain such instances of contact-action as we are considering, for (*a*) the oxidation of SO_2 or NH_3 in the presence of an excess of O_2 does not appear to be brought about by contact with *cold* platinum sponge; (*b*) it has no application in the case of the combination of NO and H_2.

3. To say that the gases are "encouraged" (as is said in at least one text-book) to combine, by the hot metal, is a mere metaphorical blind, and altogether unscientific.

Other substances besides finely-divided platinum are known to effect similar changes, when they are heated, by mere contact action, though in a less marked degree. We must seek therefore in another direction for an explanation which shall include all the known instances, and this may perhaps be found in those *thermo-dynamical principles which underlie the kinetic theory of gases.*

Proposed Theoretical Explanation of the Phenomena.

Starting with the law that the kinetic energy of a gas is proportional to its absolute temperature, and with the view that the total resistance of a gas is the sum of the energies of motion of its constituent molecules, it does not follow that this energy of motion is *the same in all the molecules;* the temperature indicated by the thermometer must rather be regarded as the mean of the temperatures (energies of translation) of the molecules. This would seem to follow from a consideration of the fact that during infinitely short periods of time the motions of individual molecules proper to their absolute temperatures must be affected as regards their intensity (velocity) by mutual impact, as is the case with all elastic bodies; also from the further fact that the effect (as regards energy of translation) of the impact of individual molecules against the rigid walls of the containing vessel cannot be the same as that resulting from their mutual collision. Again, since a molecule has weight, the energy of translation of each molecule must be slightly affected by gravitation, according as it is pursuing an ascending or descending path with reference to the Earth, though the number of ascending and descending molecules being equal, this does not interfere with the equality of tension of the mass of the gas upon all parts of the enveloping surface. These considerations would seem to hold good in a gas (or mixture of gases) at constant temperature,—that is to say, when there is no measurable accession of heat to, or withdrawal of heat from, the system. While, however, heat is being applied to the system from without, or withdrawn from it, the variations of the energy of translation of the individual molecules will be much greater.

Further, the atoms themselves must be regarded as carriers of dynamical energy, and with variations in the heat energy (absolute temperature) of the free molecules there must be variations also in the intensity of the energy with which the variations of the atoms take place within the molecules; in other words, there must be variations in the atom-temperatures along with variations in the energy of translation of the molecules themselves. The different degrees of stability of molecules of different kinds is thus seen to be accounted for by the different ranges of what we may call the *fields of intensity of the chemical affinity* which the constituent atoms (or radicles) possess for one another: the more intense their mutual attraction, the wider is the range within which the vibratory motion (atom-temperature) may increase without the atoms themselves passing beyond that range, or becoming *dissociated.*

"Dissociation-temperature"—so far as individual molecules are concerned—may be taken, then, to represent simply a sufficient increase in the vibratory motions of the atoms to carry them beyond the range of the attraction of affinity which holds them together in the molecule. Now since both the energy of translation of the molecules and the atom-temperature vary within wide limits, it follows that in a given mass of gas there must be some molecules which require a smaller accession of heat from

* Read before the British Association, Birmingham Meeting, Section B.

† The author has obtained very marked results with pumice-fragments (previously well calcined) for SO_2+O_2, both well dried ($2SO_2+O_2=2SO_3$). He has also obtained less marked, but quite distinct, traces of oxidation of NH_3 with heated pumice-fragments, as explained in the text of the paper when spongy platinum is used.

without the system than is required by those which are in the condition of the mean dynamical intensity of the system, in order that they may be dissociated. This is what is known as the *initial temperature of dissociation*.

If the mean temperature of the system be maintained constant above that of the initial-temperature of dissociation, a certain percentage of the gas will be dissociated, the percentage varying with the excess of the absolute temperature of the system over that of initial dissociation. For the same temperature (other things being equal) the same percentage of the gas is dissociated, but not the same identical molecules; new molecules are continually undergoing dissociation, while some of the previously dissociated atoms, owing to diminution in the intensity of their vibratory motion, enter again into molecular union; so that for complete dissociation one of two things is required,—either the removal from the system of the isolated atoms (at least of one kind) as fast as they become dissociated, or an enormous elevation of temperature of the whole system.

An illustration of this principle is furnished by the case of steam, which begins to undergo dissociation (at a pressure of about one atmosphere) at a temperature somewhere between the melting-points of silver and platinum, since a quantity of oxyhydrogen gas can be obtained by passing water-gas (H_2O) through a white-hot tube of platinum, or by dipping a white-hot ball of the same metal into water; that is to say, the initial temperature of dissociation lies between the melting-points of silver and platinum. Reflecting further on the fact that the intense heat of the oxyhydrogen blowpipe-flame is produced by the union of the two elements of water, we see that the temperature of complete dissociation of steam lies far above that of even the oxyhydrogen flame. As a corollary to this it follows that in the intensely hot inner flame of the oxhydrogen blowpipe the oxidation of the hydrogen is not completed, some of the gases passing beyond it in the dissociated state, and uniting to form steam in the outer mantle of the flame, where the temperature is lower.*

Instances are well known to chemists in which an accession of heat to the system may result from a rearrangement of portions of the system, as when, on the initial temperature of dissociation being reached in a body of tolerably complex molecular structure, such as ammonium nitrate, the isolated atoms of oxygen and nitrogen on the one hand, and of oxygen and hydrogen on the other, though supplied with sufficient atom-temperature to remove them out of the range of the field of intensity within which, at lower temperatures, they were held together in the ammonium nitrate molecule, are yet only possessed of such a degree of intensity of vibratory motion as is well within the range of the field of intensity of the attraction of oxygen atoms for nitrogen atoms and hydrogen atoms respectively. Even if in this case we regard the nitrous oxide as merely a reduction product resulting from the action of nascent hydrogen furnished during the first stages of decomposition, the bearing of the facts upon our present investigation is the same; heat is generated within the system by the energy set free by the formation of molecules of steam, if not by the formation of molecules of nitrous oxide. Again, when oxyhydrogen gas, or a mixture of hydrogen and chlorine, is exploded, the initial dissociation produced by the spark-discharge enables the atoms of opposite electro-chemical energies to combine, and that with such a degree of energy as to affect very rapid dissociation of contiguous molecules followed by a cross combination of their atoms to form new molecules (steam or HCl, as the case may be); the heat of combination being so greatly in excess of that expended in dissociation, added to that which escapes from the system, that the degree of the intensity reached by the heat of the system is momentarily enormous. In such a case as that of the combustion of a mixture of ammonia (a stable compound) and oxygen, this excess is comparatively small, and the rise of temperature of the system is so slow, that the progress of the flame through the mixture can be followed with the eye; while in the presence of a considerable proportion of an inert gas (such as nitrogen), which acts as a diluent, this excess becomes a negative quantity, so that atmospheric air does not support the combustion of ammonia.

Bearing all these considerations in mind it may not be difficult to see how the intervention of a porous or finely-divided solid, such as spongy platinum or platinised asbestos, may facilitate dissociation, and so start the combination of gaseous bodies, which in their free molecular state do not, under ordinary physical conditions, act upon one another. The enormous increase of the solid surface must lead to a corresponding increase of the number of collisions in a given time between the individual molecules and that surface; and the consequence of this may be (and probably is) that internal work is done among the atoms of the molecules by increasing the intensity of their vibratory motion. It would result from this, that, so far as the molecules thus affected were concerned, a smaller accession of heat from without the system would be necessary to bring about initial dissociation; that is to say, the initial temperature of dissociation would be lower than without the intervention of the finely-divided solid body. So much for the "bombardment of the molecules against the solid surface." It is even conceivable that in certain cases the molecules may be so unstable that the intervention of the finely-divided solid may be a sufficient agency (without any addition of heat externally to the system) to cause the initial-temperature of dissociation to be reached.

Those who have repeatedly performed the experiments in the cases mentioned in the early part of this paper will probably have noticed (in the case of the oxidation of SO_2, for example, by contact action) that the action begins at first very slowly and increases in intensity as it proceeds, as if from the accumulation of heat from within the system, the energy of combination of SO_2 and O being probably greater than that required to dissociate wholly or partly the antecedent molecules. In the oxidation of NH_3 into nitric oxide and steam (disregarding the further action of these bodies on one another and on the residual ammonia and oxygen present), a higher initial temperature is found to be necessary, as the result of the greater solubility of the NH_3 molecule.

There are two or three considerations not to be overlooked.

(1) In the case of stable gases, such as NH_3 or NO, the experiment only seems to succeed when there is a large excess of the other body, which is more easily dissociated—O_2 in the one case, H_2 in the other; the presence of the greater number of dissociated atoms thus secured increasing the chances of their intervention under suitable conditions between the comparatively few dissociated atoms of the more stable gas before these re-combine, as their temperature falls, while they are carried on and away from the contact influence. An example of something analogous to this is seen in the five different nitrogen compounds obtained by the action of zinc (and some other metals) on nitric acid of different degrees of density.

(2) The action goes on more rapidly (within limits probably determined by the stability of the resulting compounds) as the temperature of the solid body is raised, as if the increased radiation from the powerfully radiating surface of the porous body helped to increase the vibrations of the atoms and so to facilitate dissociation.

(3) Reflecting upon the viscosity or internal friction of the molecules of a gas (or mixture of gases), may we not ask whether the introduction of the porous or finely-divided solid in our experiments may not lead to the substitution of friction of molecules against the solid surfaces for friction of the elastic molecules against one another to such an extent that it plays an important part, when

* *Vide* Wislicenus, *Kurzes Lehrbuch der Anorganischen Chemie*, § 104.

transformed into intramolecular work, in promoting dissociation?

The Quasi-nascent State.

By this term, which the author is in the habit of using, is meant that there is not probably actual dissociation in all the molecules which take part in the reaction (though there may be in some of them); but the intramolecular work done upon the atoms produces such a tendency towards or near approximation to dissociation, that when molecules in such a state of tension (if the term may be allowed) approximate in space sufficiently to one another, the atoms of opposite electro-chemical energies in the two kinds of molecules can separate out from their original molecules under the influence of their mutual attraction, so as to unite to form the new compound. We may illustrate this very well by reference to more tangible examples; as (1) the rapid action of Cl_2 upon H_2O, even without the aid of strong light (which is necessary for the production of free oxygen in chlorine water), when a reducing agent, such as SO_2, is present; (2) the readiness with which NO_2 surrenders one of its oxygen atoms to SO_2 in the lead chamber. In both cases it would seem that the residual affinity of the sulphur-atom of the SO_2 is sufficient, when added to the counter-attraction of the Cl_2 in the first case and of itself in the second, to bring the oxygen atom out of the range of the field of the attraction within which it was previously held.

Collateral Evidence of the Truth of the Theory.

1. In a discussion in Section A last year Sir William Thomson said:—"If we take an absolutely elastic globe and cause it to rebound between two parallel and absolutely smooth planes in a region where gravity does not act, it will go on moving between the two. But he did not believe this would go on for ever. The translational energy of the ball will get transformed into higher and higher modes of *vibration*, so that at last the ball will come to rest, as it will be impossible for this energy to be transformed into translational energy." This is perhaps the clearest statement that could be made of the purely dynamical aspect of the cases we are considering; and a little reflection will show that this transformation would result (in the case of molecules) in the elevation of the atom-temperature or vibrational energy of the atoms; that is to say, energy of translation is partly expended in intramolecular work, which produces (or tends to produce) dissociation. In the case of a porous or finely divided solid we have not two parallel planes but an indefinite number of solid surfaces, multiplying indefinitely the frequency and number of instances of impact of the molecules upon the solid surface. This illustration enables us to understand the possibility, in some cases, of dissociation and consequent reaction between different kinds of atoms without any external application of heat to the system.

2. A reference must be made to Mr. Crookes's beautiful instrument—the Radiometer. The rotation of the vanes in this instrument is undoubtedly due to the difference of temperature of the polished and blackened surfaces of the plates, owing to the high degree of absorptive (and emissive) power possessed by the latter, and the high reflective power possessed by the former, for radiant energy; the result of which is that when radiation in excess is entering the instrument the temperature of the blackened surfaces is relatively raised by the greater degree of absorption, and, conversely, when radiant energy in excess is escaping from the instrument, the temperature of the blackened faces is lowered relatively by the greater degree of their emissive power, as compared with the highly-polished metallic faces of the plates. Action and reaction being always equal in quantity and opposite in direction, the rotation of the vanes must be directly proportional to the extent to which the energy of bombardment of the molecules of the highly-rarefied medium upon the blackened surfaces *exceeds* the energy of bombardment of the molecules upon the polished surfaces, when a positive direction of rotation is given to the vanes, or *falls short of it* when a negative direction is given to them. It may not be easy to decide how far, in a highly-rarefied medium, the change in the force of the bombardment of the surface, whose temperature is slightly raised or lowered, is divided between a change in translational energy of the molecules and the additional *spring* which is given to the atoms themselves; but the fact is patent enough, even for changes of temperature which are almost infinitesimal as compared with the elevation of temperature produced from without in most of the experimental processes of the kind we are considering in this paper.

3. In a lecture given in May last, at the Royal Institution, Mr. Frederick Siemens showed that contact of a flame with highly-heated surfaces tends to *prevent the inter-combination of dissociated atoms*, with a corresponding loss of heating power in high-temperature furnaces This is a result which we should expect to follow as a deduction from the theory advocated in this paper, if that theory is the true explanation of the facts; and these experimental results on a large scale may be accepted as evidence, while we regard the retardation of combination which he describes as following from the action of purely thermo-dynamical causes, rather than by supposing (as he does) that it is brought about by what he calls an "adhesive or condensing influence of surfaces on the atoms of the gas," for which there would appear to be no foundation either in thermo-dynamical principles or in experimental work, except in such very special instances as the formation of alloys of hydrogen with palladium or platinum.

The explanation offered in this paper of contact action as promoting combination between gases, which in the free state and under ordinary physical conditions do not act chemically upon one another, has at least the scientific merit of being applicable to *all* cases of the kind, which is more than can be said for any other explanation of the phenomena which has been offered hitherto. It has also, perhaps, the further merit of grouping together the chemical changes produced by the contact action of a solid, which takes no part in the chemical change itself, with those produced by purely physical agencies, as being all referrible to the same thermo-dynamical laws. Among the latter may be mentioned the combinations effected by the spark discharge, the silent electric discharge (as in the synthesis of NH_3), the continuous spark stream (as in the case of the oxidation of N_2 in dry air), and light (as in the synthesis of HCl). There is also, it will be seen, a considerable extension of our idea of the action of elementary atoms in the nascent state.

ON THE NATURE OF SOLUTION.*

By Professor W. A. TILDEN, F.R.S.

FOR want of time the consideration of various phenomena connected with the subject was necessarily omitted. Thus no reference could be made to the various formulæ relating to expansion or density of solutions, nor to their optical properties, magnetic rotation, nor to the subject of electrolysis.

In what follows a review is presented of the principal phenomena observed in the act of solution of solids (especially metallic salts and other comparatively simple compounds) in liquids, and the chief properties of the resulting solutions, with the object of arriving, if possible, at some conclusion as to the physical explanation of the facts. The question must at once arise whether these phenomena are to be considered as chemical or mechanical, and all the theories which have been put forward to explain the nature of solution are roughly divisible into

* Abstract of Opening Statement in the Discussion on the "Nature of Solution," British Association, Birmingham Meeting, Section B.

two classes, according as, on the one hand, they represent the process as a kind of chemical combination, or, on the other, explain the phenomena by reference to the mechanical intermixture of molecules or by the influence of the rival attractions of cohesion in the solid and liquid, and of adhesion of the solid to the liquid. The former hypothesis seems to have been universally adopted by the older writers, such as Henry and Turner, and it seems pretty clear that Berthollet also regarded solution as an act of chemical combination. Among modern chemists Professor Josiah P. Cooke takes a similar view. But M. Berthelot is the most consistent and powerful supporter of the same hypothesis. In his "Mecanique Chimique" (tome ii., p. 160) will be found a very clear and formal statement of his views upon this subject, which it is interesting to know are retained by M. Berthelot without modification in any essential particular.

On the other hand, there are a number of writers who —whilst referring the phenomenon of solution to a molecular attraction of some kind — do not attribute solubility to the formation of chemical compounds of definite composition. Graham distinctly ranges himself on this side; Brande also appears to have taken a similar view; and Daniell, Miller, Nicol, and Dossios may be more or less ranked with them. A theory differing in some important respects from those of the above writers was briefly enunciated in a paper communicated to the Royal Society by Tilden and Shenstone in 1883. In discussing the connection between fusibility and solubility of salts, the authors point out that the facts tend to "support a kinetic theory of solution, based on the mechanical theory of heat. The solution of a solid in a liquid would accordingly be analogous to the sublimation of a solid into a gas, and proceeds from the intermixture of molecules detached from the solid with those of the surrounding liquid. Such a process is promoted by rise of temperature, partly because the molecules of the still solid substance make longer excursions from their normal centre when heated, partly because they are subjected to more violent encounter with the moving molecules of liquid." This theory, however, only relates to the initial stage of the process of solution, and does not sufficiently explain saturation, nor the influence of dissolved substances upon vapour pressure, specific heat, specific volume, &c. How far is it true that evolution of heat indicates chemical combination? does the evolution of heat which often takes place on dissolving a solid in water, or on adding more water to its solution, indicate the formation of hydrates, *i.e.*, compounds of the dissolved body with water, in definite proportions? Thomsen answers this question in the negative (*Thermochemische Untersuch.*, iii., 20).

Take the case of sulphuric anhydride (SO_3). It is evident from the diagram exhibited that more than half the total evolution of heat occurs on addition of the first molecule of water to the solid substance; yet the succeeding molecules give quite an appreciable thermal change. At what point in such a curve should we be justified in setting up a distinction between the effect due to chemical combination and that due to other causes, such as the change of volume consequent on dilution, or the possible loss of energy from the adjustment of the motion of the molecules of the constituents to the conditions requisite for the formation of a homogeneous liquid, or (though not in the present case) the decomposition of the compound by the water?

In the act of solution of solids, and especially of anhydrous salts, in water, the volume of the solution is always less than the sum of the volumes of the solid and its solvent, with the exception of some ammonium salts in which expansion occurs. Similarly the addition of water to a solution is followed by contraction. This contraction may be due to mere mechanical fitting of the molecules of the one liquid into the interspaces between the molecules of the other (*see* Mendeleeff, Abstract in *Journ. Chem. Soc.*, February, 1885, p. 114). This would probably not be attended by loss of energy. Or, again, the contraction may arise from the re-adjustment of molecular motion already referred to.

If we know the coefficient of expansion of the liquid and its specific heat, we can calculate the amount of heat evolved for a given contraction. If this is done for sulphuric acid, and many other cases, it is found that, after accounting for the thermal change due to alteration of volume alone, there is a surplus of heat evolved which may really indicate some kind or some amount of chemical combination.

Thomsen has found that, as a rule, the heat of solution and of dilution are both either positive or negative. Of thirty-five salts examined, only four supply well-marked exceptions.

However we may ultimately explain the anomaly exhibited by these salts, the fact remains that the heat evolved or absorbed during the admixture of any substance with water is in every case a continuous function of the quantity of water added. Similarly the contraction which ensues on diluting an aqueous solution proceeds continuously, and the molecular volume of a salt in solutions of different strengths is continuously greater the larger the amount of salt present. So that in none of these thermal or volumetric phenomena is any discontinuity observed, or any indication of the formation of compounds of definite composition, distinguishable by characteristic properties.

The question we are now considering, as to whether in a solution the solvent and the substance dissolved in it—or any portion thereof—exist independently of each other, is in some degree answered by the facts known as to the specific heats and vapour pressures. For instance, when water is added to a solution of sodium nitrate, the molecular heat of the resulting liquid seems to show that all the water added is influenced, at least until a very large quantity is present. In this case one molecule of sodium nitrate can affect the movements of 100 molecules of water, and probably more. It is also well known that the vapour pressure of water holding in solution almost any dissolved solid is less than the vapour pressure of pure water, and that the boiling-point of a liquid is raised by the addition to it of any soluble non-volatile substance. This fact of reduction of pressure can only be explained upon the hypothesis that there is no free water present at all; that is, that there is no water present which is not more or less under the influence of the dissolved substance. What becomes of water of crystallisation forms a part of the same question as to the relation of solvent to solvent. Observed facts lead us to conclude that white copper sulphate, blue anhydrous cobalt chloride,—and, by analogy, other salts which are colourless,—retain their hold upon the water of crystallisation when they are dissolved in water. A very important observation has been made by Dr. Nicol, which bears directly upon this question. In his study of the molecular volumes of salt solutions he finds that when a salt containing water of crystallisation is dissolved, this water is indistinguishable by its volume from the rest of the water of the solution. In the Report presented to the British Association last year the following passage occurs:—"These results point to the presence in solution of what may be termed the anhydrous salt, in contradistinction to the view that a hydrate, definite or indefinite, results from solution; or, in other words, no part of the water in solution is in a position, relatively to the salt, different from the remainder." These two statements, however, are not strictly consequent upon each other. The view seems preferable that (save, perhaps, in excessively dilute solutions) the dissolved substance is attached in some mysterious way—it matters not whether it be supposed to be chemical or physical—to the *whole* of the water. We cannot otherwise get over the difficulty presented by the hydrated salts which give coloured solutions, by the control of the vapour pressure by the dissolved salt, and by the altered specific heat. With regard to water of crys-

tallisation, E. Wiedemann has shown that hydrated salts in general expand enormously at the melting-point; and the observations of Thorpe and Watts on the specific volume of water of crystallisation in the sulphates of the so-called magnesium group show that—whilst the constitutional water occupies less space than the remaining molecules—each successive additional molecule occupies a gradually increasing volume. So that when a salt, with its water of crystallisation, passes into the liquid state (either by melting or by solution in water) it requires a very slight relaxation of the bonds which hold the water to the salt for it to acquire the full volume of liquid water, whilst the water of constitution is not so easily released. And this conclusion accords with Nicol's observations on the molecular volumes of the salts when in solution.

Now comes the question as to what determines the solubility of a substance. Why, for example, is magnesium sulphate very soluble in water, whilst barium sulphate is almost totally insoluble? With regard to salts the following propositions seem to be true:—(1) Nearly all salts which contain water of crystallisation are soluble in water, and for the most part easily soluble. (2) Insoluble salts are almost always destitute of water of crystallisation, and rarely contain the elements of water. (3) In a series of salts containing nearly allied metals the solubility and capacity for uniting with water of crystallisation generally diminish as the atomic weight increases. The fusibility of a substance has also much to do with its solubility. Neither fusibility alone nor chemical constitution alone seems to be sufficient to determine whether a solid shall be soluble or not, but it may be taken as a rule, to which there are no exceptions, that when there is a close connection in chemical constitution between a liquid and a solid, and the solid is at the same time easily fusible, it will also be easily soluble in that liquid.

Salts containing water of crystallisation may be considered as closely resembling water itself, and these are, for the most part, both easily fusible and easily soluble in water. But space is wanting for the discussion of the details of these matters, as well as the relation of molecular volume to solubility of solids.

The fascinating character of the phenomena of supersaturation has attracted a host of experimenters; but no definite explanation has been generally accepted. In the opinion of the speaker supersaturation is identical with superfusion. Supersaturated solution of (say) alum, thiosulphate of sodium melted in its water of crystallisation, and fused sulphur at 100° exhibit phenomena of exactly the same kind.

Finally, we are led to the consideration of what is meant by chemical combination. From the phenomena under discussion, and others, the conclusion seems inevitable that chemical combination is not to be distinguished by any absolute criterion from mere physical or mechanical aggregation; and it will probably turn out ultimately that chemical combination differs from mechanical combination—called cohesion or adhesion—chiefly in the fact that the atoms or molecules of the bodies concerned come relatively closer together, and the consequent loss of energy is greater.

WATER ANALYSIS.

THE following letter, addressed to Mr. Crookes, Chairman of the Chemical Section of the British Association for the Advancement of Science, arrived too late to admit of its being brought before the notice of the Section:—

SIR,—At the meeting, held this month, of the American Association for the Advancement of Science, a Committee was appointed to report a scheme, for general adoption, of stating the results of the analysis of waters, both potable and mineral.

The chief points to be discussed by the Committee are—

1. The scale upon which the results shall be given,—whether parts per 100, 1000, 100,000, or 1,000,000, or grains per gallon, &c.
2. The method of naming the constituents determined,—whether, for instance, in the case of a mineral water, the basic and acid substances shall be given separately, or whether the salts supposed to be present; or whether we shall say so much Na, K, Ca, Mg, S, as sulphate, &c.

As you are well aware, there is a great variety of methods of stating these results of water analysis, and the desirability of a uniform method cannot be questioned.

It was suggested in our Chemical Section of this Association, when this Committee was appointed, that perhaps the Chemical Section of the British Association might be willing to co-operate with us in this matter. To this end I lay the action of the Chemical Section before you, trusting that you will take such steps concerning it as may seem proper.

Our Committee reports a year hence, at the next meeting of the American Association. If this should reach you in season for any corresponding action by your Section, we should be pleased to be put in communication with the Committee appointed.—Yours respectfully,

G. C. CALDWELL,
Chairman of the Committee.

Chemical Department, Cornell University,
Ithaca, N.Y., August 28th, 1886.

A PROBLEM IN CHEMICAL BIBLIOGRAPHY.

APPENDIX TO REPORT OF COMMITTEE ON INDEXING CHEMICAL LITERATURE.

By H. CARRINGTON BOLTON.

IT IS no disparagement to the profession to say that not all chemists are bibliographers; the peculiar talents and skill which ensure success in laboratory researches have no necessary connection with the technical erudition of bibliography. In preparing for publication records of their researches, chemists generally aim to chronicle the previous labours of others in the same or analogous lines, but in quoting from periodicals the writers sometimes give little thought to their accurate and systematic designation. A lack of uniformity is especially marked in the abbreviations by which the journals are indicated, these abbreviations often requiring for their comprehension a "scientific use of the imagination." Many circumstances, national and individual, combine to produce confusion; the customs of divers countries vary greatly, and when English-speaking chemists adopt the abbreviations of French titles in use by German authorities, the result is not satisfactory from a bibliographical standpoint. The different tastes of some individuals, the thoughtlessness of others who seldom write a title twice in the same way, lead to the employment of many abbreviations for a single journal. Lest we may be accused of exaggeration we give a single example of this multiplicity of abbreviations; the voluminous and influential *Berichte der deutschen chemischen Gesellschaft zu Berlin* is referred to by writers in the following ways:—

B.
B. B.
Ber.
Ber. d. chem. Ges.
Ber. d. deutsch. chem. Gesellsch.
Ber. Berl. chem. Ges.
Berl. Ber.
Berichte.
D. C. Ges.
Deutsch. ch. Ges. Ber.

and doubtless in many more variations. Many other instances will occur to our readers who need no arguments to admit the desirability of a reasonable degree of uniformity in abbreviations of this kind.

When engaged in compiling "A Catalogue of Chemical Periodicals" (London, 1885) the writer contemplated adding thereto a list of abbreviations of the titles catalogued, but a sense of the inexpediency and futility of an assumption of authority caused an abandonment of the plan. Recently the subject has been broached by correspondents of the Committee on Indexing Chemical Literature, and a statement of the case seems advisable.

The existing lists of abbreviations for chemical periodicals, having a degree of completeness and possible authority, are not numerous. That monumental work of the Royal Society:—"A Catalogue of Scientific Papers (1800-63)," 8 vols., 4to, 1867-80, London, is the first to which one in search of reliable data would turn, but unfortunately this great work is bibliographically very unsatisfactory. The abbreviations of titles follow no definite plan, the first word abbreviated is sometimes the place of publication, sometimes the editor, and sometimes the first word of the title. We find such inversions as "Geol. Soc. Proc.," such redundant expressions as "*Gistl, Faunus*," and other evidences of a lack of system and of economy of space. The abbreviations in this catalogue cannot be adopted as standard.

Several chemical journals which furnish their readers with abstracts of contemporary literature have their own lists of abbreviations, but these are limited to journals now current, and the host of discontinued journals remain unprovided for. Nor are the abbreviations used by any means ideal: Thus we find in the valued *Jahresbericht * * * der Chemie*, several objectionable abbreviations, such as "Sill. Am. J." for the veteran American periodical which was so long associated with the name of Silliman; "Lond. R. Soc. Proc." in which the disorder is objectionable, an objection also applicable to the abbreviation, "*Russ. Zeitschr. Pharm.*"

In Mr. S. H. Scudder's Catalogue of Scientific Serials, we find an "Index to Titles," which is suggestive in many points although not prepared for use as abbreviations; nor does it give the abbreviations of Society transactions, the words Annals, Berichte, Journal, Bulletin, &c., being dropped for convenience. The care with which the abbreviated titles were prepared is, however, manifest in the skilful differentiation of expressions similar in orthography.

The most systematic and extended list of abbreviations of journal-titles appears to be that accompanying the Index-Catalogue of the Library of the Surgeon-General's Office, U.S.A. (Washington, 1880), and prepared by Drs. Billings and Fletcher. In this the authors clearly lay down the following principles for the construction of abbreviations on a uniform plan.

1. To follow the exact order of words of the title.
2. To make the abbreviations as brief as is consistent with clearness to those familiar with medical literature.
3. To follow strictly the orthographical usages of each language. This disposes of the question of capitalization.
4. To attain uniformity as far as possible.
5. The place of publication is generally added.

This work is intended for medical journals exclusively, but includes naturally a considerable number of chemical works. In the rules above quoted we find a basis for action, a definite method applicable to periodicals of every department of learning. While admiring the perspicuity of the contractions, the high degree of uniformity attained, and the consistency with which the rules are applied, we are, nevertheless, of the opinion that the abbreviations in this Index-Catalogue are in many cases unnecessarily long and cumbersome. This arises partly from retaining the initials of articles occurring in the title, partly from frequent addition of the place of publication even when it does not form part of the title, and largely from the praiseworthy attempt to be consistent, especially in applying Rule 1. A single example taken from chemistry, will suffice to illustrate the occasion of our criticism. The well known journal popularly known as "*Berzelius' Jahresbericht*" has assigned to it the following abbreviation:—"*Jahresb. ü. d. Fortschr. d. phys. Wissensch. v. Berzelius, Tübing.*" This work is one of many having similarly unwieldy titles, and surely the abbreviation just given errs in like manner; chemists hastily noting the source of a reference cannot be expected to employ abbreviations of this character. Briefly, they are too consistent to be expedient.

Many journals, which have been conducted for a long series of years by a single editor of distinction, are known by that editor's name joined to the principal word of the title. While this is perhaps admissible in colloquial speech, abbreviations of these conventional titles are sometimes obscure and perplexing. Again, journals are sometimes quoted by prefixing the place of publication to the contracted titles, and this is another source of confusion. The propriety of avoiding these abbreviated, conventional titles in references is unquestionable, yet the most ardent adherent of bibliographical accuracy will hardly succeed in inducing chemists to forego speaking in such well established phrases as Silliman's Journal, Poggendorff's Annalen, Wagner's Jahresbericht, and Dingler's Journal, notwithstanding the fact that no persons of these names are longer connected with the respective periodicals. We do not believe perfect consistency between the spoken names and written abbreviations either necessary or desirable. On the other hand, the adoption of different names for different series of the same periodical, merely because a new editor has come into control, is a method of giving references which in our opinion cannot be too strongly condemned. In an exceedingly valuable work of reference, published last year, the author who adopts this unfortunate method designates a well known journal by no less than three sets of abbreviations, and is forced to admit that these are not always correctly applied. When the change of editorship is accompanied by renumbering of volumes the objection has less weight.

Many of the existing lists of abbreviations are designed to fill a special need in a particular work and are not suited to general use. This is true of the abbreviations in Dr. Carnelley's Melting and Boiling Point Tables, where restricted space demanded utmost condensation. In these tables the single letter "A" stands for Annalen der Chemie, "B" for the Berichte der deutschen chemischen Gesellschaft, "J" for Jahresbericht * * der Chemie, &c.

This suggests that the methods of designating periodicals may for convenience be classified in two groups, those in which a single letter is used, or at most two or three initials somewhat arbitrarily chosen, and second, those consisting of contractions of the words of the title; the first style may be called symbols, and the second contractions; both these classes occur in the abbreviations in general use.

The Problem in Chemical Bibliography which we have sketched in a desultory way is one which concerns not merely chemistry but the whole range of scientific literature. We think, however, that each branch of science should find its own interested expositors, and for this and other reasons we here limit the question to subjects properly coming before the Chemical Section.

The Problem has a two-fold aspect; first, in what way can a standard list of abbreviations of chemical periodicals be best prepared? and, secondly, How can such a standard list be presented to American chemists in a way to secure the widest acceptance? We propose that a co-operative effort be made to solve this problem, and suggest that it be referred to the Committee on Indexing Chemical Literature, reinforced by two bibliographers, to be added to its membership.

Trinity College, Hartford.
August, 1886.

Dr. Bolton's proposal for a Standard List of Abbreviations of Journal Titles was warmly endorsed by the Chemical Section, and the matter was referred to the Committee, with power to add to their number. This Committee is now constituted as follows:—Profs. H. Carrington Bolton, of Hartford; Albert R. Leeds, of Hoboken; F. W. Clarke, of Washington; A. A. Julien, of New York; John W. Langley, of Ann Arbor: Mr. S. H. Scudder, of Cambridge; Prof. Charles K. Wead, of Malone.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING AUGUST 31ST, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, September 7th, 1886.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from August 1st to August 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 175 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

The general character of the water supply of the month was unexceptionable. The mean proportion of organic carbon in the Thames-derived supply was 0·132 part, with a maximum of 0·157 part in 100,000 parts of the water, as against a mean of 0·146 part, and a maximum of 0·177 part in the preceding two months' supply.

Following up the series of bacteriological experiments with sterilised distilled water, described in our previous monthly report, we next made several series of more or less similar experiments with ordinary Thames-derived town-supply water. In one of these series of experiments the water was sterilised by repeated ebullitions, with removal by filtration of the earthy carbonates thrown down by the first ebullition. In another series the ebullitions were effected during the passage of a current of sterilised carbonic acid gas through the water, so as to maintain the earthy carbonates in solution; while in yet another series of experiments, made with a somewhat different object, the two modes of effecting the sterilisation were employed indifferently, the removal or retention of the earthy carbonates having been found without apparent influence on the bacteriological results. In each case addition of distilled water more than sufficient to compensate for loss by vaporisation, was made before sterilisation of the town-supply water, which was ultimately boiled down to just its original volume. After its sterilisation the water was allowed to become re-aërated by standing in cotton-plugged flasks before being subjected to experiment.

Seventeen experiments, all of them in duplicate, were made with sterilised town-supply water, from which the earthy carbonates had been deposited by ebullition. The experiments were set going for the most part on different days, from March 19th to March 31st, inclusive. In each experiment a quantity of peptone fluid, loaded with an active sporeless growth of *Bacillus anthracis*, was added to the sterilised water in the proportion of about 1-150th of its bulk. To contaminate even a single day's supply of water to London, in the same degree, would require an addition thereto of at least a million gallons of bacillus-charged animal fluid; or an addition of at least half a million gallons of this same fluid to the eighty or so million gallons of the Thames-derived daily supply. The water, infected as above, was kept at about the temperature of the air of the room, which, in the course of different experiments, varied from 59° to 64° F. (15° to 18° C.). After different intervals of time tubes of sterilised culture-fluid were next sown with the infected water and subjected to incubation at 90° F. (32° C.). The general result of this series of experiments was as follows. The culture-fluid, when sown with the infected water, within three hours of its being infected, invariably developed on incubation an abundant characteristic growth of bacillus. On the other hand, the results afforded by sowing with the infected water, after it had been infected from four to seven hours, were very irregular—so much so that in some cases there was no development in the incubated culture fluid sown with a four hours' infected water, while in other cases there was development in the like culture fluid sown with a seven hours' infected water. Sowings after the lapse of more than seven hours had to be put off until the next morning, and were made habitually after an interval of eighteen hours from the original infection. In fifteen out of the seventeen duplicate experiments these sowings were found to be infertile; and as regards the two exceptional instances, in one of them the sowing with one of the two duplicate lots of water experimented on was infertile. Moreover, sowings made on the next following morning with the exceptionally behaving examples of infected water were in both instances infertile; showing that these waters, though retaining their power of setting up a growth of bacillus for an exceptionally long time, nevertheless lost their power within a couple of days.

Subsequent investigation showed that the extreme duration of infectivity in purposely infected water, extending in two experiments of this series to over eighteen hours, varied according to the proportion of nutrient animal fluid with which the water was contaminated. As already mentioned, the proportion of nutrient matter added to the river water made the subject of this series of experiments was extravagantly large. With a yet greater proportion there was observed to be a yet longer extreme period of infectivity; while conversely, with a lessened proportion there was observed to be a shorter period of infectivity, which, in the case of river water still contaminated with nutrient fluid to about one-fourth of the extent employed in the above series of experiments, was found not to exceed six hours. Particulars of a series of experiments establishing this result will be given in our next monthly report.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

The Composition of Forest Air.—E. Ebermayer.—The proportion of carbon dioxide in the air of woodlands is not sensibly smaller than that of the air of the open fields. The influence of a wood of 1 hectare in furnishing oxygen is neutralised by the respiration of four persons. The entire forest territory of Bavaria gives off yearly to the atmosphere 20 "milliard" kilos. of oxygen. —*Biedermann's Centralblatt fur Agrik.-Chem.*, xv., pt. 5.

VERIFICATION OF THE CALCULATION OF THE ATOMIC WEIGHTS OF M. STAS.

By J. D. VAN DER PLAATS.

(Concluded from p. 172.)

C. *Molecular Weights of the Alkaline Chlorides and Bromides.*

I HAVE calculated the molecular weights of these salts according to their relation to silver, taking Ag = 107·93.

We get at the same values by deducting the molecular weight of a chloride from that of a corresponding nitrate. The difference represents $NO_3 - Cl$, and is greater than the atomic weight of nitrogen by 48 − 35·456 = 12·544.

In the year 1865, while submitting some results to calculation under the law of probabilities, M. Stas found N = 14·044 with a probable error of 0·000718. The probability that the true value would be N = 14·05 was 0·00004, and that N = 14·055 it would be 0·0 . . . (twenty zeros) 02. The last value seemed excessively improbable. But in 1882 M. Stas admits that N = 14·055 according to the synthesis

IX.	Independent value deduced from $KClO_3$.	KCl	74·6143	74·5681	74·6022 [74·5898]
X.	,,	KCl	74·6013	74·5991	74·6002
XI.	,,	NaCl	58·5046	58·5011	58·5030
XII.	,,	NH_4Cl	53·5344 53·5338	53·5319	53·5331 53·5329
XIII.	,,	KBr	119·0975	119·0833	119·0884*
XIV.	,,	NaBr	103·0083	103·0038	103·0061
XV.	,,	NH_4Br	98·0347	98·0326	98·0340
XIX.	,,	LiCl	42·4823	42·4777	42·4801

* According to experiment No. 9.

To control the average results more rigidly we calculate as follows:—

$KBr - KCl = 119·0884 - 74·6022 = 44·4862$
$NaBr - NaCl = 103·0061 - 58·5030 = 44·5031$
$NH_4Br - NH_4Cl = 98·0340 - 53·5330 = 44·5010$

According to the at. wts. admitted, Br − Cl = 44·499

D. *Atomic Weights of the Alkaline Metals.*

We calculate these with the average results (C), admitting Cl = 35·456 and Br = 79·955.

$KCl - Cl = 39·1442$ or $39·1462$
$KBr - Br = 39·1334$
$NaCl - Cl = 23·0470$
$NaBr - Br = 23·0511$
$NH_4Cl - Cl = 18·0770$
$NH_4Br - Br = 18·0790$
$LiCl - Cl = 7·0241$

The atomic weight of potassium, calculated from the chloride, is more probable than that deduced from a single estimation (No. 9) of the bromide.

From this there results:—

	Possible error.
K = 39·144	0·01
Na = 23·049	0·005
NH_4 = 18·078	0·005
Li = 7·024	0·01

E. *Molecular Weights of Nitrates.*

We accept KCl = 74·6; NaCl = 58·503; LiCl = 42·48; Ag = 107·93.

XVII.	KNO_3	101·1933	101·1864	101·1897
XVIII.	$NaNO_3$	85·1041	85·0925	85·0980
XX.	$LiNO_3$	69·0726	69·0675	69·0706
XVI.	$AgNO_3$ (dried)	169·9858	169·9853	169·9856
XVI.	$AgNO_3$ (melted)	169·9749	169·9676	169·9713

With NaCl = 23·049 + 35·456 = 58·505 we get for the average value of $NaNO_3$ = 85·1009.

F. *Atomic Weight of Nitrogen.*

Admitting K = 39·144, Na = 23·049, Li = 7·024 Ag = 107·93, we deduce the molecular weights of the nitrates.

of nitrate of silver dried at its melting-point, the relation of the specific gravities of nitrogen and oxygen gases, and according to the three last transformations of chloride of sodium into nitrate.

But the specific gravities of gases are not a reliable means of calculating atomic weights exactly. M. Stas himself says:* "The only means at arriving at a true relation is to found the data on gravitation" (*Bulletin de l'Académie Belgique*, 1880, vol. l., p. 411). Besides, Jolly (*Wiedermann's Annalen*, 1879, vol. vi., p. 529) has fixed the relation of the specific gravities of oxygen and nitrogen at 0° and 720 m.m. at about—

Maximum .. 16 : 14·0826
Minimum.. .. 16 : 14·0782

Mean .. .. 16 : 14·0802

If the composition of nitrate of silver was definitely fixed we should prefer it to all other means of calculating the atomic weight of nitrogen. It is probable that the transformations of chloride which have given the maximum of nitrate are the nearest to the truth. But so long as the question, What is the normal composition of nitrate of silver? is not answered, so long will the atomic weight of nitrogen be uncertain.

I admit as correct:—

	Possible error.
N = 14·05	0·01

This uncertainty is the more annoying as it deprives us of a method of controlling the relation between oxygen and hydrogen. In fact, as NH_4 = 18·078 and N = 14·04 to 14·06, H_4 = from 4·038 to 4·018, and the relation—

$$\frac{O}{H} = 15·85 \text{ or } 15·93.$$

Even in giving full weight to the uncertainty which exists about the atomic weights of silver, chlorine, and bromine, it is impossible to admit that NH_4 is less than 18·065, and I conclude from this that $\frac{O}{H}$ is less than 16·†

* "La Science et l'Imagination."

† By the estimation of the water, which is produced by the oxidation of a known volume of hydrogen (15 litres), I have recently found this relation to be 15·94 to 15·96.

				M. Stas, p 288.
KNO_3	14·0493	14·0424	14·0457	14·043
$NaNO_3$	14·0551	14·0435	14·0490 14·0519	14·048
$LiNO_3$	14·0486	14·0435	14·0466	14·046
$AgNO_3$ (dried)	14·0558	14·0553	14·0556	14·044 to 14·047
$AgNO_3$ (melted)	14·0449	14·0376	14·0413	

G. *Atomic Weight of Lead.*

Admitting S = 32·06 and N = 14·05 we deduce for lead :—

XXII.	$PbSO_4$	206·9411	206·8320	206·9028
XXI.	PbN_2O_6	207·0272	206·8816	206·9550 [206·9417]

The last synthesis gives—

with N = 14·044 .. .. .. 206·9355
and N = 14·055 .. .. .. 206·9721

But the synthesis of the nitrate leaves grave doubts, that of the sulphate being far more delicate than all the others. I have, therefore, some hesitation in proposing :—

	Possible error.
Pb = 206·91	0·05

In conclusion I give a table of the results of all my calculations :—

extract is then evaporated to dryness, and the nitric acid is determined in the aqueous solution of the residue.

In determining ammoniacal nitrogen the expulsion of the ammonia is effected by caustic magnesia. The use of potassa or soda is rejected, to obviate the decomposition of any cyanides present. To ensure the complete decomposition of ammonium-magnesium phosphate, if present, the sample is previously treated with an acid.

As indicator in titration litmus alone is to be used; phenolphthaleine is inadmissible.

Organic nitrogen is to be determined according to the Will-Varrentrapp method. When it is difficult to take a sample (leather, wool, &c.) a large portion is treated with sulphuric acid and an aliquot portion is submitted to combustion.

In mixed manures the ammoniacal nitrogen is determined by decomposition with caustic magnesia, and in

Atomic Weights, O = 16.

	According to M. Stas.			According to my results.		
	1860. α 335.	1865. β 23.	1882. γ 64.	Atomic Weight.	Possible Error.	Logarithm.
Ag	107·943	107·930	107·930	107·930	0·01	2·0331422
Cl	35·46	35·457	—	35·456	0·005	1·5496897
Br	—	79·952	—	79·955	0·01	1·9028456
I	—	126·850	—	126·857	0·01	2·1033144
S	32·0742*	—	—	32·06	0·01	1·5059635
K	39·13	39·137	39·1425	39·144	0·01	1·5926652
Na	23·046†	23·043	23·0455	23·049	0·005	1·3626521
Li	—	7·022	—	7·024	0·01	0·8465845
N	14·041	14·044	14·0550	14·05	0·01	1·1476763
Pb	206·906 (sulphate) —		—	206·91	0·05	2·3157815
	206·920 (nitrate) —		—			

* Calculated from the analysis of sulphate of iron, admitting Ag = 107·943.
† M. Stas gave 23·05 (β 290) by mistake.

Molecular Weights.

Table.		Calculated direct from experiment. Ag = 107·93.	Formulæ.	From the sum of admitted atomic weights. (ammonium excepted).	Logarithms.
D		18·077 to 18·079	NH_4	18·078	1·2571504
C	X.	74·6022 to 74·6002	KCl	74·600	1·8727388
C	XI.	58·5030	NaCl	58·505	1·7671930
C	XIX.	42·4801	LiCl	42·480	1·6281845
C	XII.	53·533	NH_4Cl	53·534	1·7286297
	IV.	143·39095	AgCl	143·386	2·1565068
C	XIII.	119·0884	KBr	119·099	2·0759081
C	XIV.	103·0061	NaBr	103·004	2·0128541
C	XV.	98·034	NH_4Br	98·033	1·9913723
	VI.	187·8718	AgBr	187·885	2·2738921
	VIII.	234·7885	AgI	234·787	2·3706740
E	XVII.	101·1897	KNO_3	101·194	2·0051548
E	XVIII.	85·0980	$NaNO_3$	85·099	1·9299245
E	XX.	69·0707	$LiNO_3$	69·074	1·8393146
E	XVI.	169·9856 to 169·9713	$AgNO_3$	169·980	2·2303978

REPORT OF THE COMMISSION OF FRENCH AND BELGIAN CHEMISTS, ON THE METHODS OF EXAMINING MANURES.

(EXTRACT).

Determination of Nitrogen.

FOR nitrogen present as nitric acid the method of Schlœsing is adopted. The purity of the nitric oxide gas evolved must always be tested by its complete absorption in an acid solution of ferrous sulphate. The determination is always effected in an aqueous extract.

In mixed manures containing organic matter, in which filtration is difficult, the sample is first treated with lime and then extracted with 50 per cent spirit. The alcoholic

the residue the organic nitrogen according to Will-Varrentrapp.

In manures containing nitric acid and ammonia, each kind of nitrogen is determined according to the method as laid down for it above.

In substances containing nitric acid and organic nitrogen the nitric acid is determined according to Schlœsing, and the organic nitrogen according to Will-Varrentrapp, in a fresh portion from which the nitric acid has been expelled by treatment with ferrous chloride or oxalic acid.

Total nitrogen is determined on the principle of Dumas, by combustion with copper oxide. Ruffle's method can be applied only after the expulsion of the ammonia. Kjeldahl's method is repudiated, as in presence of nitrates chlorine may be liberated from the chlorides and decompose ammonia.

Determination of Potash.

In examining crude potassium chloride the platinum method is preferred; in mixed manures the method of Corenwinder. The sample must be ignited prior to analysis. The determination of potassa as perchlorate is too costly, on account of the large quantity of absolute alcohol required.

Corenwinder's Method. — The aqueous solution is strongly acidified with hydrochloric acid, and mixed with excess of platinum tetrachloride. The liquid is evaporated on the water-bath to a moist mass, and when cold digested in alcohol and ether. It is then placed on a filter, and washed with alcohol and ether until the filtrate is colourless. The potassium-platinum chloride remaining on the filter is dissolved in boiling water, when a yellowish residue is left undissolved. The solution is decomposed at a boil with solution of sodium formiate until colourless, and the precipitate of platinum is washed with hydrochloric acid, dried, weighed, and from its weight the potash is calculated.

Determination of Phosphoric Acid.

Total phosphoric acid is to be determined by dissolving the sample in hydrochloric acid and precipitating the phosphoric acid in an aliquot portion by means of magnesium citrate and ammonia. After twelve hours the precipitate is filtered, washed, dissolved in dilute nitric acid 1 : 10, sodium acetate added, and the liquid titrated with uranium nitrate.

The determination of soluble phosphoric acid is to be effected in an aqueous extract; reverted acid is to be dissolved by digesting the residue with ammonium citrate.—*Chemiker Zeitung.*

NOTICES OF BOOKS.

History of the Royal College of Surgeons in Ireland, and of the Irish Schools of Medicine; including numerous Biographical Sketches; also a Medical Bibliography. By Sir CHARLES A. CAMERON, P.R.C.S., Ireland. Dublin: Fannin & Co. London: Baillière, Tindall, and Cox. 1886. Royal 8vo.

THIS work, which has been written by the Professor of Chemistry to the Irish Royal College of Surgeons, will be read with great interest by all lovers of scientific history, comprising as it does in a complete manner an account of the foundation and rise of medical science and education in Ireland. It contains the biographies of several distinguished Irish chemists; for example, Sir Robert Kane, Professors Apjohn, Barker, Gregory, and Reynolds, and it gives much interesting information relative to scientific discoveries in Ireland, particularly to those made by Whitley Stokes (cousin of the present President of the Royal Society), McBride, and others. The book consists of about 750 pages, divided into twenty-one chapters. The opening chapter describes the progress of medical knowledge in Ireland from the earliest ages, and gives an account of medical works published in Ireland up to the year 1700. The second chapter details Irish medical biography in the eighteenth century. In Chapter 3 we find the history of the Barber-Surgeon's Guild in Dublin, incorporated in 1446, being by sixteen years the earliest incorporation of medicine in the United Kingdom. Chapter 4 gives a long account of medical education and institutions in Great Britain and Ireland prior to the nineteenth century. Then in eight chapters the history of the Irish College of Surgeons is given, two of them being devoted to an account of the college library and museum. The next chapter contains an account of the connection of the college with the Army and Navy Medical Departments, and is prefaced by a historical notice of British and Irish Army Surgeons from the time of McLiog, surgeon to King Brien Boru, who met the fate of so many other Irish kings, by being killed in battle at Clondarf in 1014.

The lives of the seventy-three Presidents of the college are given in three bulky chapters, whilst the five remaining ones are devoted to an account of the medical schools of Ireland and the lecturers in them. Altogether nearly three hundred biographies are given, amongst which will be found the names of almost every distinguished Irish medical man of the present and former ages. The work may be regarded as a history, in some respects a full one, of Irish medicine and medical men. It contains numerous anecdotes, and abounds in quotations from curious old Irish works, describing medical men, surgeons, and apothecaries; it is adorned by numerous engravings and furnished with a copious index.

Proceedings of the Eighth Annual Meeting of the New York State Pharmaceutical Association, held in Rochester, January 8th, 9th, and 10th, 1886. Elmira, New York: Advertiser Association.

THIS report contains much interesting matter. From a paper contributed by Dr. R. G. Eccles it appears that salicylic acid is not a substance which can be indiscriminately used with safety. Hence we may fairly infer that its use to prevent fermentation in foods and beverages is open to very grave objections, since it may frequently thus find its way into the system of persons to whom it is likely to prove dangerous.

"Glucose syrup" seems to have given rise to considerable discussion. No one will, of course, contend that the natural sugar of the grape is unwholesome; but an artificial glucose may vary in quality according to the raw material used and the reagents employed. From evidence which has reached us it appears that the American glucose, made from maize-starch, is a wholesome product. Whether as much can be said in favour of the glucose manufactured on the European continent, from potatoes, is a very different question. Alcohol obtained by means of the fermentation of the potato is especially rich in the deleterious higher alcohols, such as the amylic. Hence it would seem that such glucose must be accompanied by undesirable by-products not found in the true grape-sugar.

The question of the sale of alcoholic liquors by pharmacists was considered at some length, and, whilst all the members present wished that they should not be degraded to the position of liquor-dealers, much diversity of opinion prevailed. In one district it appears that all pharmacists who made affidavit that they would not sell liquor except for strictly medicinal purposes are not required to take out a license.

The subject of the adulteration both of food and drugs engaged the attention of the Association. Two materials had been handed to Dr. Eccles, one used for adulterating pepper and the other for adulterating mustard. "These are from a large New York house, and all their business consists in sending them out for use as adulterants."

Of another substance, not distinctly named, but probably nux vomica, we read—"It is made into pills, and while the normal dose is three pills, a person could easily take from one to two hundred without any injury."

In a discussion upon a paper on the hypophosphites, read by T. D. McElhence, we find a remark on the comparative wages paid to manufacturing chemists in London and in America. It is said—"An Englishman receives more pay than an American. The idea that Americans receive more pay than Englishmen is fallacious." This statement will be received with surprise.

Newcastle-upon-Tyne Mining, Engineering, and Industrial Exhibition (International and Colonial). Royal Jubilee Year, 1887.

IN spite of the strong doubts entertained in many quarters whether "international" exhibitions are calculated to be

in the least beneficial to a country placed under such circumstances as is the United Kingdom, the *furore* for these displays shows few symptoms of abatement. This, however, is a matter lying outside the sphere of the CHEMICAL NEWS.

The document before us gives a list, *in extenso*, of the vice-presidents, members of executive council, executive committees, and other officials. The divisions of the intended display are — Coal-mining and products; machinery; marine engineering and machinery, and naval architecture; civil, military, railway, and hydraulic engineering; building industries; chemical industries, including the three classes alkali, glass, and paints and oils; fisheries, agriculture, horticulture, and arboriculture, including manures; hygiene, arranged under the heads of warming and ventilating, gas-lighting and manufacture, and electric lighting; food; sundry industries and products, including tanning and paper-making; art in industries; and, lastly, science and education.

Reid's Patent Indexed Ready Reckoner, showing the value of 1 to 50,000 Articles at any given rate from $\frac{1}{16}$ of a Penny to a Pound, with Tables of Weights and Measures. London: Hamilton, Adams, and Co. Newcastle-on-Tyne: Sidney Reid.

THIS work, which has been checked by an experienced accountant, will effect a great saving of time in commercial establishments.

The tables of weights and measures cannot be considered as on a level with the age. There is no mention of the metric system, with which every person doing a foreign business requires to be familiar. Concerning Troy-weight we find the obsolete statement that it is used "in philosophical experiments." Such is not the case. Wherever weighing occurs in any scientific experiments the standards used are either the gramme or the grain, each with its multiples or sub-multiples; the troy pennyweight, ounce, &c., being entirely laid aside.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Justus Liebig's Annalen der Chemie, Vol. ccxxxiv., Part 3.

Researches on Titanium.—(First Treatise).—Baron Otto von der Pfordten.—The author concludes from his experiments that: Pure sulphuretted hydrogen gas is obtained by removing oxygen with chromous chloride and drying with phosphorus pentoxide. Hydrogen gas obtained in the ordinary manner from zinc and acid contains no admixture of oxygen. For titanium and a number of other elements having a strong affinity for oxygen the sulphides are better obtained from the chlorides and sulphuretted hydrogen than by the action of carbon disulphide, which does not yield pure products. At low temperatures sulphuretted hydrogen reduces titanium tetrachloride, and forms at higher ones another compound, probably a sulpho-chloride. At a red heat there is formed pure crystalline titanium disulphide, into which the former products are converted. Titanium disulphide is oxidised by a current of carbonic acid free from oxygen. In a current of nitrogen or in a current of hydrogen at the temperature attainable in a glass tube, it is resolved into sesquisulphide. At the red heat of platinum it is reduced by hydrogen to monosulphide. The author compares and describes the sulphides just mentioned.

On China Bicolor.—O. Hesse.—The author concludes that Hodgkin's results, described in the *Pharmaceutical Journal*, were due to the accidental admixture of a quantity of the bark of *Remijia pedunculata*.

Contributions to the Knowledge of the Azo- and Diazo-Compounds.—O. Wallach.—The author describes the conversion of nitrotoluidine into para-aceto-meta-toluylendiamine, para-acetamido-toluol-ortho-azo-dimethyl-aniline, para-amido-toluol-ortho-azo-dimethyl-aniline, toluol-ortho-azo-dimethyl-aniline para-azo-phenol, toluol-ortho-azo-dimethyl-aniline para-azo-β-naphthol, para-acetamido-toluol-ortho-azo-diethyl-aniline, ortho-aceto-meta-toluylen-diamine, ortho-acetamido-toluol-para-azo-dimethyl-aniline, ortho-amido-toluol-para-azo-dimethyl-aniline, acetamido-benzol-meta-azo-dimethyl-aniline, and amido-benzol-meta-azo-dimethyl-aniline.

On Cinchol.—O. Hesse.—The author shows the identity of this substance with Liebermann's cholestol or oxyquinoterpene.

Journal für Praktische Chemie. New Series, Vol. xxxiv., Part 2.

Synthesis and Constitution of the Two Acids

$$(1{\cdot}4)\ C_6H_4\begin{cases}COOH\\C_3H_7\end{cases}$$

—Richard Meyer.—The author discussses here the synthesis of cuminic acid, the preparation of isopropyl-bromide, the synthesis of cymol, the preparation of cuminic acid from synthetic cymol, and the synthesis of para-propyl-benzoic acid.

Part 3.

On Ortho-paradinitro-sulpho-benzolic Acid and its Derivatives.—C. Willgerodt and P. Mohr.—This acid is very hygroscopic and deliquescent. It forms long, transparent, pale yellow crystals, of the thickness of the thumb, and containing 3 mols. of crystalline water. The anhydrous acid is readily soluble in water, in lyes, and in alcohol, sparingly soluble in ether and glacial acetic acid, insoluble in benzol and boiling petroleum ether. If the acid is mixed with an excess of alkali it assumes at once, even in the cold, an intense dark yellow colour, which points to the abscission of the sulpho-group and the transformation of the sulphacid into a salt of *a*-dinitro-phenol.

The Decomposition of the Vapour of Ethyl Ether by a Current of Induction Sparks.—M. von Klobukow.—The products of the decomposition are oxygen, carbon monoxide, hydrogen, CH_4, and nitrogen. The author recognises in the extraordinary decomposing power of the arc, and of the current of induction sparks, the result of the united actions of thermic and electric energies, which energies occur simultaneously in especially favourable proportions in the above sources of force. By increasing one or other of these energies we are able to obtain the proportion necessary for a given decomposition. For each decomposition this proportion is naturally a constant which in a secondary degree may be influenced by other forms of energy, such as magnetism, light, &c. The state of a chemical compound exposed to the action of such a combination of forces may be likened to the "critical condition" of gases.

Promiscuous Notes.—Dr. J. Walter.—These notices comprise the introduction of H_2N by means of sodium amide, the application of phosphoric anhydride as a desiccating agent, the author recommending that it should be compressed into a compact mass, the flocculent state being very inconvenient; and on the occurrence of acridine in the last product obtained during the distillation of crude diphenylamine.

The Electrolysis of Normal Capronic Acid by Alternating Currents. — E. Drechsel. — The author's experiments prove that in electrolysis with alternating

currents there are obtained quite different products from those yielded by currents of a constant direction.

On the Radicle Paracyanogen and its Compounds with the Halogens. — Peter Klason. — Paracyanogen contains at least six carbons in its molecule, and bears the same relation to the paracyanides as does free cyanogen to the cyanogen compounds.

On β-Naphtho-acridine.—J. H. Reed.—The author obtained this base, hitherto unknown, in long straw-coloured needles, which melt at 216°.

Bulletin de l'Association des Elèves de M. Fremy. 2nd Series, No. 6. April, 1886.

Review of Certain Qualitative Analytical Procedures founded upon Micro-Chemical Reactions,—L. Bourgeois. — This paper will be inserted at some length.

On Different Simple Methods for recognising Silver, Nickel, and Tin deposited in Thin Layers on Metallic Objects.—L. Loriton.—The first method consists in scorching the object in the oxidising flame of a Bunsen burner, and observing the series of colouration-phenomena shown by the surface under the progressive action of heat. This series is constant, and sharply characteristic of each of the three kinds of surfaces considered. The second process, still more simple, consists in plunging the object for some minutes into a strong, boiling solution of sodium chloride. In the former method we observe successively, in case of a surface coated with nickel, a yellowish grey colour, distinct violet reflections, a blue colour with bright black reflections, and, lastly, a uniform grey tint with green reflections. A surface coated with tin shows a dirty yellow-grey colouration; slight violet reflections, rapidly passing off; a grey tint with a dotted surface, and a wrinkled surface with distinct yellow spots. A silvered surface shows at first no change appreciable by the naked eye; small violet points; an abrupt change to a uniform grey with white points and a yellowish grey wrinkled surface. With the solution of sodium chloride the results obtained are — with nickel a reddish violet colouration at the end of ten minutes; with tin, a dull grey colouration scarcely to be distinguished; and with silver, nothing. Dilute ammonium hydrosulphate, slightly heated, blackens silver, strips tin, and has no action upon nickel.

Apparatus of M. Schauffler, chiefly intended for the Determination of Nitrogen in Ammoniacal Salts and of Carbonic Acid in the Carbonates.—This apparatus cannot be usefully described without the accompanying figure.

New Model of an Incineration Furnace.—V. Wiesnegg.—The same remark applies to this device.

Antidotes for the Poisonous Chemical Products commonly used in Industry.—For phenol, creosote, tincture of iodine, and phosphorus, use white of egg well beaten up in water and a spoonful of mustard in warm water. If sulphuric, nitric, or hydrochloric acid, or aqua regia has been swallowed, take chalk stirred up in the smallest possible quantity of water. For chromic acid, the chromates, chrome colours, and antimonial preparations, such as tartar emetic, use white of egg in abundance, and a mustard emetic except in case of tartar emetic. Tea of marine herbs (?) is also recommended. For ammonia, potash, soda, alkaline silicates, and hydrosulphates, employ vinegar, followed up with oil or milk. For hydrocyanic acid, the cyanides and sulpho-cyanides, oil of bitter almonds, and nitro-benzol, pour cold water upon the head and spine, apply mustard to the soles of the feet and the region of the heart, and keep the patient awake. For ether, petroleum, benzol, fruit essences, or strong alcohol, use a strong mustard emetic with plenty of warm water, cold water and fresh air externally, and keep the patient awake. For compounds of lead and barium use the mustard emetic, and give Epsom or Glauber's salts. For arsenic and its compounds, the mustard emetic, dialysed iron with magnesia, and then oil, milk, or mucilaginous liquids. For oxalic acid and soluble oxalates use chalk, lime-water, and castor-oil. For silver nitrate take common salt dissolved in water, and finally the mustard emetic. For gaseous nitrogen oxides use small quantities of acetic acid as strong as it can be taken.

Carbon Disulphide Burner.—M. Ckiandi.—The apparatus here described and figured serves to generate sulphurous acid for disinfecting rooms, ships, wearing apparel, &c.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 7, July, 1886.

Production of Azo-Colours.—The dyes obtained by the action of the phenols upon thion-aniline appear to be industrially useless, whilst those extracted from thio-paratoluidine are very valuable. We dissolve, *e.g.*, 40 kilos. thio-paratoluidine in 500 litres of water with 120 kilos. of ordinary hydrochloric acid. After letting the solution stand for three hours the liquid is poured into a mixture of 145 kilos. soda lye at 33° B., and a solution of 130 kilos. sodium-β-naphthol-bisulphate in 1000 litres of water cooled down to 5°. The colour obtained is salted out and purified by repeated solution. Industrial dyes are also prepared by the action of diazothio-paratoluol upon the sulph-acids of the α and β naphthols and of the α and β naphthylamines. The colours obtained from the naphthol sulph-acids furnish tones ranging from brown to reddish blue, whilst those yielded by the naphthylamine sulph-acids give tones ranging from a yellow to a red-brown. The colours produced by the naphthol sulphoacids β are remarkable for the slowness with which they are deposited upon the fibre and their fastness on washing.—*Dingler's Journal.*

MISCELLANEOUS.

Fuels: their Uses and Economy.—A free introductory lecture to this course, to be held during the coming Winter at King's College, London, will be given by Mr. W. G. McMillan, F.C.S., at 7 p.m., on Monday, October 11th, the subject being "Heating Methods and Fuels of the Past and Present."

Congo-Red as a Reagent for Free Acid.—Prof. Hugo Schulze.—The author has utilised Congo red to decide the question whether the lower animals produce free acid internally. It dissolves readily in water and has the advantage of not disturbing the vital functions of the lower animals. He found, *e.g.*, that Rotatoria are stained distinctly blue in their digestive region, whilst their other parts remain white if a drop of a strongly coloured solution of Congo red is allowed to flow under the covering glass; the existence of free acid is thus demonstrated, though its nature can scarcely be determined. —*Central-Blatt für Med. Wissenschaft* and *Chemiker Zeitung.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Utilisation of Oak Shavings.—I have a considerable quantity of fine oak shavings. Can any of your correspondents suggest a method of utilising the same?—O. P. Q.

TO CORRESPONDENTS.

Homo de Scotia.—We do not understand the question.

THE CHEMICAL NEWS.

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WATER OF CRYSTALLISATION IN SOLUTION.*

By W. W. J. NICOL, M.A., D.Sc., F.R.S.E., Lecturer on Chemistry, Mason College, Birmingham.

When a hydrated solid salt is dissolved in water it is generally considered that the molecules of water of crystallisation remain as an integral part of the salt and distinct from the remainder of the water present in the solution.

In the course of experiments on the molecular volumes of dissolved salts I was led to a conclusion entirely opposed to the generally received view, inasmuch as I found that the whole of the water in a solution possessed the same molecular volume, and that it was impossible to distinguish between water of crystallisation and solvent water. I was thus led to examine more closely the evidence in support of the commonly accepted view, and the following paper consists of an attempt to summarise the existing evidence on this point and to ascertain the bearing of this evidence.

There are in all three sources from which we can hope to obtain information sufficiently exact and complete to enable us to approach an answer to this problem. These are—

1. Thermo-chemical evidence, comprising data as to heats of solution, of hydration, of neutralisation, &c.
2. Volume-chemical evidence (to employ the English form of the term used by Ostwald), consisting of measurements of the molecular volumes of salt solutions, and the change of volume on double decomposition, &c.
3. Evidence derivable from the colour of dissolved salts. This is of necessity limited in its range, but is of very considerable importance at first sight.

The evidence obtainable from a careful study of thermo-chemical results is the most complete, if not the most conclusive, at our disposal, and is generally regarded as proving the existence of water of crystallisation in solutions,—at least of those salts which, when dehydrated, evolve heat on solution in water. The form of the argument is as follows:—

When a crystallised hydrated salt is dissolved in water heat is absorbed, while, on the contrary, when the same salt is dehydrated and then dissolved in water, heat is evolved. It is therefore clear that hydration occurs on solution. But the argument is in this form incomplete and fallacious; for it ignores the fact that the sum of the thermal changes in the above actions expresses the heat of hydration of the solid salt by means of liquid water, and that no account is taken of what may occur after the solid hydrate is formed. The argument is completed by adding that, if the solid hydrate formed above is split up again on solution, then the heat of hydration disappears from the scene, and the heat of solution is that of the dehydrated salt: but this is positive, while the heat of solution of a salt which does not crystallise with water is negative; there is thus a constant difference in the behaviour of the two classes of salts. To what can this be due, if not to hydration?

Before attempting to answer this question let us consider whether we have any grounds for assuming, as is usually done, that the heat of hydration of a solid salt is any measure of the affinity existing between that salt and water. At first sight this would certainly appear to be the case, but on further reflection it is found that a great many other circumstances have to be taken into consideration. Thus there is the thermal change due to the passage of the water from the liquid to the solid state: this has to be deducted from the heat of hydration, and is a very large amount, in some cases exceeding the whole heat of hydration, so that the heat of hydration of cadmium chloride, minus the heat of change of state of $2H_2O$, is a minus quantity. This is, it is true, an extreme case, but the others are similar; there is not the slightest trace of a connection to be observed between the heat of hydration and the number of water molecules in the hydrate. Salts with an exceedingly small hydration heat per molecule of water unite with 10 or 24 molecules; others, with six times as high a value, unite only with 2 or 6 molecules of water. Surely nothing more need be said to prove that water of crystallisation and heat of hydration are not connected in the very simple way that is generally assumed.

Our knowledge of thermo-chemistry is not I believe sufficiently advanced to enable us to solve this problem; still I think it is possible to trace out the probable explanation of this apparently anomalous behaviour of salts. In nearly every chemical action, and certainly in the hydration of salts, there are involved not only chemical but also physical changes. Thermo-chemistry of necessity makes, in very many cases, no distinction between these two, as they appear to be inseparably connected, and no means are at hand to enable us to assign to each part of the change its correct thermal value. So far all is right, but what is unjustifiable is the custom of assigning chemical significance to a thermal change which has its origin in physical as well as chemical changes; and this is, I believe, what is done with the heat of hydration. When a dehydrated salt unites with water to form the solid hydrate, it is not sufficient to deduct from the thermal change the value of the change of state of the water, and then to assume that the remainder is the measure of the chemical affinity existing between the salt and the water, for that leads to an absurd result in the case of cadmium chloride, and, as I have shown, to no result with other salts from which it is possible to trace out a connection between water of crystallisation and corrected heat of hydration. There can, then, be no doubt that the process of hydration involves other changes, probably physical, in addition to those already taken account of.

It is to the probable nature of these that I wish to direct attention. The heat of fusion of three salts has been examined,—chromate, phosphate, and thiosulphate of sodium,—and has been found to be respectively 12,300 cals., 23,900 cals., and 9,400 cals. Now these numbers comprise not only the liquefaction of the water, but also that of the salt. In each case, the change of state of the water being deducted, we have −2,100 c., +6,600 c. and +2,200 c., and for $CaCl_26H_2O$ the figures are 8,900 c. and +0,273 cal.

There is thus no relationship to be observed; in one case the liquefaction of the salt is attended by an absorption of heat, as was to be expected, but, on the other hand, it produces the most varied amounts of heat in three cases out of four. The formation of a solid hydrate is then of a very complicated nature, and one in which the chemical affinity between salt and water probably plays but a secondary part, the physical changes undergone by both salt and water accounting in many cases for nearly the whole of the thermal change,—in some cases for more than all.

Passing now to the act of solution of a solid anhydrous salt, such as NaCl. This is in nearly every case an endothermic process, and at first sight it is difficult to understand how it is possible for it to dissolve at all, for spontaneous chemical changes are always exothermic,

* Discussion on the "Nature of Solution," British Association, Birmingham Meeting, Section B.

while solution is endothermic and yet spontaneous. When, however, we regard it not as a chemical action, but as a physical one, partially if not entirely as a change of state, then the anomaly disappears, for we find that spontaneous physical changes may be endo- or exothermic, as the case may be. Thus evaporation is always endothermic, but the conversion of sulphur from the prismatic to the octahedral form is exothermic, and many other cases will occur to my readers; the explanation apparently being that purely physical changes, when endothermic, are seldom if ever attended by degradation of energy, but exothermic changes are, and are not reversible in the same way as endothermic changes.

It is, I think, the case that the purely physical change from the solid to the liquid state is always endothermic; there is also no doubt that there exists an attraction (physical or chemical) between the molecules of salt and the molecules of water which produces contraction, and that this is exothermic. The thermal change attending solution will therefore depend for its sign on the relative values of these + and − changes. Now it seems probable, as will be seen later, that the + value above is a constant for most salts in dilute solution, and this is supported by the fact that the effect of a molecule of salt in diminishing the vapour-pressure of water is very nearly constant, as is shown not only by my results, but also by those of Wüllner and Tammann. Now the + side of the thermal account being a constant, it follows that the total depends solely on the magnitude of the − side; that is, on the thermal change attending the passage of the salt from the solid to the dissolved state: this is an entirely physical process, and consists in the separation of the molecules from one another. If we assume for a moment that this is large in the case of anhydrous salts, and small in that of the dehydrated ones, then all is perfectly clear. Is there any ground for such an assumption? There is indeed little doubt that hydrated salts are more soluble than corresponding anhydrous salts, — *e.g.*, Na_2SO_4 than K_2SO_4, $BaCl_2$ than $Ba(NO_3)_2$, and other instances; but a comparison of this kind is of necessity limited, for there are but a few cases in which it can be made. At present I believe it is not possible to prove that this assumption is a correct one, but it is highly probable, for, as I have shown, the thermal change on hydration is but small in many cases when that due to the solidification of the water is deducted, and in no case is it possible to connect it with the number of molecules of water of crystallisation. On the other hand, when we consider not the heat of hydration, but that of solution of the anhydrous or dehydrated salts, then we find a host of relations existing between the various salts, as pointed out by Thomsen. Thus it is probable that the act of solution is a simpler and less complex process than that of the formation of the solid hydrate. Now if the endo- or exo-thermic character of the solution of a salt be conditioned, as pointed out above, by the relative magnitudes of the force tending to produce solution and the work necessary for the separation of the salt molecules from one another, it follows that the thermal change, on dilution of the solutions thus formed, should have the same sign as that attending solution, but that there should *not* be a strict line of demarcation between the two classes; certain members of each class should behave as members of the other class on dilution. Thus it is found that nearly all salts which are endothermic on solution are also so on dilution, and *vice versâ*, but that there are a few exceptions which, so to speak, form the connecting-link between the two classes. These exceptions are $Zn(NO_3)_2$ and $Cu(NO_3)_2$ exothermic on solution, and so also on dilution with a small amount of water, but endothermic in very dilute solution. Four other salts out of the thirty-five examined by Thomsen show what he regards as anomalous behaviour, but in reality occupy the intermediate position spoken of above.

Turning now to the evidence obtainable from the thermal change on neutralisation of an acid with various bases, we find that it is conclusive against the existence of water of crystallisation in solution. I shall at present consider only the neutralisation results directly obtained, as there can be no uncertainty about them. The figures given by Thomsen are contained in the following Table, and they show most clearly that for these bases the heat of neutralisation with sulphuric acid is a constant, and with hydrochloric acid and nitric acid it is another constant, differing from the former by −3,520 cals.

TABLE I.

Base.	H_2SO_4.	H_2Cl_2.	$H_2N_2O_6$.
$Li_2(OH)_2$	31,290	27,700	—
$Na_2(OH)_4$	31,380	27,490	27,360
$K_2(OH)_4$	31,290	27,500	27,540
$Tl_2(OH)_2$	31,130	(27,520)	27,380
$Ba(OH)_2$	Insoluble.	27,780	28,260
$Sr(OH)_2$	30,710	27,630	—
$Ca(OH)_2$	31,140	27,900	—
Means	31,160	27,650	27,630

It is on this constancy of difference between the figures for H_2SO_4 and H_2Cl_2, and the exact agreement of the figures for H_2Cl_2 and and $H_2N_2O_6$, that the following argument is based. When sulphuric acid neutralises each of these bases the result is first the separation of 2 molecules of water, then the union of the metal and the salt radical to form a salt. So far the changes are common to all the salts formed, and there is no cause to wonder at the constancy of the thermal change, but if water of crystallisation exists in solution each of the salts thus formed combines with water: Li_2SO_4 with 1 molecule, and evolves 1,200 cals.; Na_2SO_4 with $10H_2O$ + 4,820 cals.; K_2SO_4 with none; Tl_2SO_4 with none; so also with $SrSO_4$; while $CaSO_4$ unites with $2H_2O$, evolving −3,300 cals. I have assumed in the above that Thomsen is correct in stating that the bases and acid themselves exist in solution without water of crystallisation; if such is not admitted the argument is only stronger.

Pass now to the chlorides and nitrates. The salts of potassium and sodium are anhydrous (so with thallium), but barium chloride unites with $2H_2O$, evolving 4,120 cals.; $Ba(NO_3)_2$ is anhydrous; $SrCl_2$ and $CaCl_2$ are both hexhydrated, evolving respectively 9,000 cals. and 13,000 cals. There is then the greatest possible diversity to be observed in the water of crystallisation, and yet the thermal results are constants. Will anyone ask us to believe that this constancy is attained by the adjustment of the heat of neutralisation proper? Surely that would be contrary to the probabilities of the case, which is enormously against that explanation, and even this last loophole of escape is closed by a comparison of the figures for the sulphates, chlorides, and nitrates of potassium and sodium. It is likewise useless to contend that a solution of a salt formed by neutralisation differs from one produced directly: all evidence is to the contrary. The thermal results for organic bases which form stable salts lead to the same conclusion; but enough has been said to justify the conclusion of Thomsen, that "different substances when in aqueous solution are in an analogous condition," and "I regard the state of solution as a condition in which substances may be compared with reference to their thermal relationships with the same success as is done in the gaseous state with regard to their other physical properties"; and this, I may add, would be impossible were water of crystallisation present.

Again, the division of a base between two acids—the "avidität" of Thomsen and the "affinität" of Ostwald —throws some further light on this subject; for no matter how this is ascertained, whether by the thermal changes or the volume changes, or by the rate of inversion of sugar or of etherification, the result is in all cases the same; and it must be noted that the first two methods *may* include water of crystallisation, but the last two *cannot*. Surely it is almost certain that nowhere, when

dealing with solutions, are the reactions complicated by water of crystallisation.

Having shown above that the thermal results are free from water of crystallisation, it remains to be seen whether water of constitution has any effect on them; for experiments on the volumes of salt solutions have led me to the conclusion that it exists in solution (see below). I believe that thermo-chemical results do show a trace of the presence of water of constitution. Unfortunately, however, none of the bases whose salts are concerned in this question are soluble in water; thus we cannot attack the question directly.

Thomsen has examined the reaction—

$$BaCl_2\ 200\ aq., MSO_4\ 200\ aq.,$$

and his results show that when—

$$M = K_2 \text{ or } Na_2,\ R = -5{,}260 \text{ cals.},$$
$$M = Mg, \&c.,\ R = -5{,}620 \text{ cals.},$$

showing a difference of 360 cals., the results of the reaction.

$$Ba(OH)_2\ aq., MSO_4\ aq.$$

cannot be considered, for they are complicated by the heat of formation of the solid hydrates $Mg(OH)_2$, &c., which are unknown. The results of partial decomposition are, however, available:—

(1) MSO_4 aq., H_2Cl_2 aq., and
(2) MCl_2 aq., H_2SO_4 aq.,

and are as follows:—

$$M = K_2 \text{ or } Na_2 \left\{ \begin{matrix} (1)\ -3{\cdot}276 \\ (2)\ +0{\cdot}554 \end{matrix} \right\} \begin{matrix} (1-2) \\ = -3{,}825 \end{matrix}$$
$$M = Mg, \&c. \left\{ \begin{matrix} (1)\ -2{\cdot}455 \\ (2)\ +1{\cdot}106 \end{matrix} \right\} \begin{matrix} (1-2) \\ = -3{,}561, \end{matrix}$$

and the difference here is ½(264 cals.), the mean of the two differences obtained from the methods of double and partial decompositions being 380 cals.,—a small amount, it is true, still exceeding the limits of experimental error according to Thomsen, for he himself says "an alteration of the relative avidität of the two acids with the nature of the base is therefore recognisable." "It appears, however, that the *avidität* varies slightly within each group of bases; for the alkalies it is 0·5–0·57, for the magnesium series it is 0·7–0·81, and these two groups therefore are distinct from each other." Ostwald has found the same by the comparison of the volume changes, but neither attempt to account for this difference, and Thomsen actually in the latter part of his work entirely overlooks the difference he has found and thus emphasized, and makes the difference in the heat of neutralisation of H_2SO_4 and H_2Cl_2 a constant for all the bases.

I wish, however, to lay stress on this point: even if this difference between the two classes of bases be due to the water of constitution, the value 380 cals. is small compared to the thermal value of hydration of the salt with 1 molecule of water, being in many cases but a tenth of what was to be expected. It is this fact that led me to regard the heat of hydration as due in most part to physical rather than to chemical changes.

We have now to consider the volume-chemical results. If dilute solutions, not more than 1 equivalent of salt to 100 molecules of water, be compared, it is found that their molecular volumes when compared in series—that is, the salts of two metals with various acids, and *vice versâ*—exhibit constant differences; thus the salts of potassium with various acids, compared with those of sodium with the same acids, have a constant difference of 10·4 units. This has been shown to hold good for twenty-nine inorganic and organic acids. Now this constant difference in volume obtains in spite of the utmost diversity in the water of crystallisation in the solid state, which varies from 0 up to $12H_2O$. This proves that all the water present in the solutions has the same volume, which could not be the case were water of crystallisation present. The same holds good for all the salts I have yet compared, with the single exception of those which contain water of constitution. Here it is found that the difference in volume between the chlorides of the magnesian series and the corresponding sulphates is markedly less than that observable between other chlorides and sulphates. This leaves us the alternative of assuming either that the water of constitution makes the difference or that for some unexplained reason these salts alone form an exception. Surely there can be no hesitation as to which is the more reasonable view. I may add here that, by water of constitution, I do not wish to commit myself to any theory as to its nature. There can be no doubt that in the magnesium sulphates *one* of the molecules of water is retained by the salt at a higher temperature than the others, if the experiment be quickly performed, though it is equally probable that complete dehydration may result from prolonged heating at a low temperature, just as ice, however cold, ultimately completely evaporates. The above difference in the behaviour of solutions of the salts of the magnesian series from others, though only observed by me, is completely supported by the results of Ostwald and others, when these are calculated in the form of molecular volumes.

Finally, we have the colour changes of solutions as throwing light on the question of hydration. A great deal of importance—far too much indeed—has been attached to these as proving the existence of hydrates in solution. The argument would indeed have great weight were it contended that cobalt chloride, for example, existed in the same state in solution as in the solid state after drying at 150° C., but such a contention is manifestly absurd. All that I maintain is that a solution is truly homogeneous, that the whole of the water present in a dilute solution stands in the same relation to the salt, and that condition can be satisfied without assuming that the salt is entirely separated from the water. In fact the vapour-pressures of salt solutions show clearly that the presence of a single molecule of salt is sufficient to disturb the equilibrium of a relatively infinite mass of water molecules. The thermal and volume changes have shown that water of crystallisation is indistinguishable from solvent water, and I believe I am justified in maintaining that there is nothing in the colour of salt solutions incompatible with this view.

It must not be overlooked that the whole of this paper has reference solely to dilute solutions. When a solution is saturated the conditions are entirely different, and there can be little doubt that at the crystallising point *some* of the salt-molecules have water of crystallisation attached to them.

ON THE ARSENATES OF CALCIUM.

By CHARLES L. BLOXAM.

In analysing the arsenate of calcium and ammonium an attempt was made to determine the ammonium in the form of $2NH_4Cl.PtCl_4$ by dissolving in HCl, evaporating with excess of $PtCl_4$, and treating with alcohol, but the platinum salt was lighter yellow than usual, and when ignited left a residue weighing half as much again as the Pt calculated. On boiling the residual platinum with strong aqua regia it left a white granular powder, quite insoluble in acids, and appearing under an inch objective in fine white, opaque, prismatic crystals.

Fused with Na_2CO_3 the substance gave $CaCO_3$, corresponding to 29·6 per cent of Ca, and $MgNH_4AsO_4.\frac{1}{2}$ aq, corresponding to 36·26 per cent of As.

The formula $Ca_3(AsO_4)_2$ requires 30·15 per cent of Ca and 37·69 per cent of arsenic.

The insoluble substance appears, therefore, to be the tricalcic diarsenate corresponding to the bone phosphate.

I then endeavoured to obtain the salt by synthesis, employing Iceland spar as the source of calcium and pure As_2O_3 for the arsenic, these being dissolved in excess of

nitric acid to convert all the arsenic into arsenic acid, evaporated to dryness, and strongly ignited to decompose and expel the excess of arsenic acid.

(1). 6·03 grains $CaCO_3$ and 3·96 grains As_2O_3($Ca_3 : As_2$) gave a residue weighing 7·98 grains. $Ca_3(AsO_4)_2$ requires 7·9998, but this was not crystalline, and was soluble in HCl.

(2). 6 grains $CaCO_3$ and 4 grains As_2O_3($Ca_3 : As_{2\cdot02}$) gave a residue weighing 8·01 grains, which lost no more on repeated ignition over a gas blowpipe. The residue was strongly alkaline, and dissolved almost entirely in HCl.

Hence it appears that 3 molecules of CaO are capable of retaining 1 molecule of As_2O_5 at a bright red heat.

Experiments were next made with gradually increasing proportions of arsenic, 6 grains of $CaCO_3$ being taken for each experiment, and the ignition conducted over the blowpipe till the weight was nearly constant.

	1.	2.	3.	4.	5.
As_2O_3 in grains	4·50	5·00	5·50	6·00	10·00
Ignited residue	8·46	9·00	9·46	9·86	11·52
Calculated $CaO+As_2O_5$	8·59	9·17	9·75	10·33	14·98

These numbers show that the amount of arsenic which remains unexpelled at a bright red heat increases rapidly with the proportion of As_2O_3 employed. This is explained by the behaviour of As_2O_3 when oxidised by HNO_3, evaporated to dryness, and ignited, when a considerable quantity of a vitreous residue remains, which diminishes in weight very slowly at a red heat, and contains both As_2O_3 and As_2O_5, being probably the same substance which is produced by heating As_2O_3 in Cl.

On boiling these residues with strong HCl it was found that in those cases in which an excess of As_2O_3 had been employed a considerable quantity of a granular powder remained undissolved. This appeared, under the microscope, to consist of groups of prisms, white and opaque, but not nearly so large as those previously obtained.

When 3 grains of $CaCO_3$ and 10 grains As_2O_3 were treated with excess of HNO_3, and strongly ignited, the residue did not give up any Ca to boiling HCl, the whole of that metal being left in the granular powder.

To determine the composition of this insoluble body it was fused with sodium carbonate, and treated as described above.

Substance.	Found.		Calculated $Ca(AsO_3)_2$.		
	Ca.	As.	Ca.	As.	Ca : As.
3·53	0·472	1·78	0·493	1·85	1 : 2
3·74	0·532	1·88	0·523	1·96	1 : 1·9
3·57	0·476	1·80	0·499	1·87	1 : 2
1·61	0·224	0·86	0·225	0·84	1 : 2·05

The insoluble substance, therefore, appears to be the calcium metarsenate, $Ca(AsO_3)_2$.

The three arsenates of calcium correspond to the phosphates.

Tricalcic diarsenate, or Orthoarsenate, $Ca_3(AsO_4)_2$.
Pyroarsenate, $Ca_2As_2O_7$.
Metarsenate, $Ca(AsO_3)_2$.

The analysis of the pyroarsenate was given in the Chemical News (vol. liv., p. 168).

I have endeavoured to obtain the crystallised orthoarsenate again by the method referred to at the commencement, but have only obtained the metarsenate.

Postscript to "Arsenate of Calcium and Ammonium" (vol. liv., p. 168).

Some light has been thrown upon the reason for the difference of opinion with respect to the amount of water in the salt, by the result of an experiment in which two samples of the salt which had been freely exposed to air for four warm days in August till the loss of weight was insignificant, were allowed to remain exposed to the air, and weighed at intervals of about twenty-four hours, until, instead of losing, they began to gain slightly as the atmospheric temperature fell. This did not happen until after thirty-six days, during which period six *minima* of loss were observed, the first occurring when the formula of the salt was $CaNH_4AsO_4.7H_2O$, and the last when the loss corresponded to a final residue of $CaNH_4AsO_4.H_2O$, the intermediate points of minimum loss in equal periods corresponding approximately to the loss of successive molecules of water. Hence, if an observer analysed the salt when the second minimum loss had been arrived at, he would pronounce it to have the composition—

$$CaNH_4AsO_4.6H_2O.$$

I regret that, not at all anticipating the result, I did not keep so careful a record of the daily hygrometric, thermometric, and barometric conditions during the thirty-six days as would enable me to plot trustworthy curves; and I look forward to another period of leisure and fairly equable temperature to extend the experiment to some other hydrated salts in order to ascertain whether any general law can be deduced as to the periods of minimum loss.

In the precipitation of calcium from waters as ammonio-arsenate, it will be noticed that it is preferable to add the arsenic acid (or ammonium arsenate) before adding the ammonia, which may, in some cases, give an immediate precipitate of $CaCO_3$ or $Mg(HO)_2$.

King's College, London, October 4, 1886.

ON SOME CHEMICAL PROPERTIES AND CONSTANTS OF SODIUM BICHROMATE.

By ARTHUR STANLEY.

Considering the growing commercial importance of sodium bichromate, which has of late years been sold on a large scale as a substitute for potassium bichromate, a more thorough knowledge of its chemical and physical properties has become desirable. At the request of Dr. Knecht I therefore undertook a series of experiments with a view of supplying some information on the chemical and physical properties of this important compound. In the first edition of Gmelin Kraut's "Handbuch der Chemie"* a brief notice is found of sodium bichromate, which is said to exist in six-sided prisms, but no other data are given.

The crystals, $Na_2Cr_2O_7+2H_2O$, were examined by Siewert, *Jahresberichte*, 1862, and *Haller Zeitschrift*, xix., 11. With the exception of what is given in the patent literature and in one or two publications describing its manufacture, very little has hitherto been published on sodium bichromate in technological or scientific handbooks or journals.

The sodium bichromate used in these experiments was one of White's (Glasgow) manufacture, which was in the condition of an almost anhydrous crystalline mass, containing a very small percentage of chromic oxide, as seen by the following analysis:—

Sodium bichromate ..	98·360
Water	1·523
Chromic oxide	0·135
	100·018

Another sample of White's crystallised commercial products, after drying, yielded the following results on analysis:—

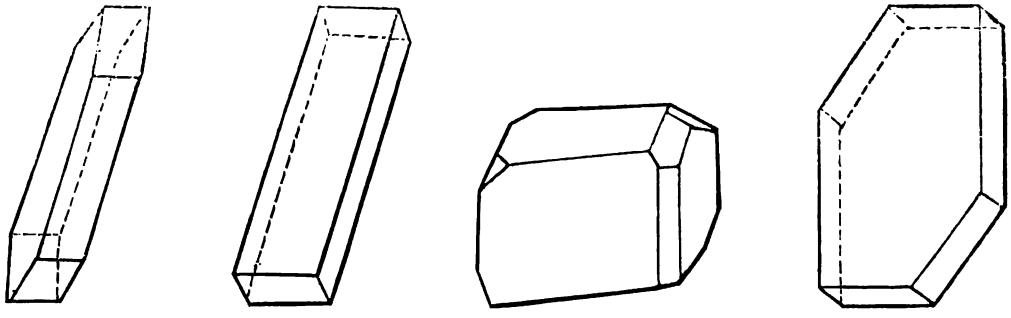
(1). 1·0660 grm. of bichromate, after boiling with strong HCl and precipitating with ammonia, gave 0·6190 grm. Cr_2O_3 = 0·8130 grm. CrO_3 = 76·2 per cent CrO_3. Theoretical, 76·3 per cent.

(2). 1·0890 grms. of sodium bichromate, after same treatment, gave 0·6330 grm. Cr_2O_3, corresponding to 99·97 per cent of $Na_2Cr_2O_7$.

* Vo. iii., p. 586.

Sodium bichromate crystallises in prisms and plates belonging to the triclinic system. When crystallised from a hot solution ir assumes the form of long prismatic needles, but when allowed to deposit from a cold solution, as in one slowly evaporating at the ordinary temperature of the air, it crystallises in short pyramid-capped prisms.

The following are the most general forms of the crystals which I observed :—



These crystals are of a deep red colour, transparent and deliquescent, and have the formula $Na_2Cr_2O_7+2H_2O$. The first molecule of water is given off on heating below 75°, while all the water is given off below 100°, leaving the anhydrous salt as a light brown mass.

The crystals of $Na_2Cr_2O_7 + 2H_2O$ have a sp. gr. of 2·5246 at 13°.

When the crystals of the hydrated salt are dissolved in water a considerable reduction of temperature occurs, while if the anhydrous bichromate be treated with water a rise in temperature is produced, thus proving that in the latter case, the salt, before solution, chemically combines with water to form a hydrate.

Water at the ordinary temperature dissolves about its own weight of sodium bichromate. One hundred parts of the saturated solution contain :—

At—	0°	15°	30°	80°	100°	139°
$Na_2Cr_2O_7$	107·2	109·2	116·6	142·8	162·8	209·7

The saturated solution boils at 139°, at which temperature it contains more than 200 parts of the salt. It is insoluble in ether, but slightly soluble in absolute alcohol, becoming more so the greater the quantity of water present; for example, 100 c.c. of strong methylated alcohol, of sp. gr. 0·8225 dissolved 2·80 grm. of sodium bichromate at 17°.

The specific gravities of the aqueous solutions of sodium bichromate are the following, taking as the strength the percentage of the salt in a given quantity of solution :— (See Table, next column).

About half the above figures are the results of direct experiment, the other half being obtained by interpolation.

Sodium bichromate has an acid reaction, and a sharp, bitter, cooling, metallic taste.

Sodium bichromate, whether in the anhydrous or hydrated condition, is very hygroscopic. In order to give an idea of the relative absorptive power for moisture of the anhydrous bichromate, I performed the following experiment: Taking coarsely powdered anhydrous bichromate and ordinary calcined, granulated calcium chloride in equal quantities (viz. 5·1679 grm.), and exposing to the atmosphere, it was found that sodium bichromate possessed about one-third the absorptive power of calcium chloride. After exposing for four hours the increase in weight in each case was :—

$CaCl_2$.	$Na_2Cr_2O_7$.
0·3489	0·1159

After forty-eight hours the increase due to absorption was :—

5·1399	1·7930

Thus it is seen that after forty-eight hours the calcium chloride absorbed about its own weight of water, while in the same time and under the same circumstances sodium bichromate absorbed approximately a little over one-third its own weight.

The anhydrous bichromate fuses at 320°, forming a transparent dark red liquid, which, on cooling, crystallises in the same forms as the hydrated salt deposited from the aqueous solution.

Percentage of $Na_2Cr_2O_7$ in solution.	Sp. gr.
1 per cent	1·007
2 ,, ...	1·014
3 ,, ...	1·021
4 ,, ...	1·028
5 ,, ...	1·035
6 ,, ...	1·042
7 ,, ...	1·049
8 ,, ...	1·057
9 ,, ...	1·064
10 ,, ...	1·071
11 ,, ...	1·078
12 ,, ...	1·085
13 ,, ...	1·092
14 ,, ...	1·099
15 ,, ...	1·105
16 ,, ...	1·113
17 ,, ...	1·120
18 ,, ...	1·127
19 ,, ...	1·134
20 ,, ...	1·141
21 ,, ...	1·147
22 ,, ...	1·153
23 ,, ...	1·159
24 ,, ...	1·165
25 ,, ...	1·171
26 ,, ...	1·178
27 ,, ...	1·185
28 ,, ...	1·193
29 ,, ...	1·201
30 ,, ...	1·208
31 ,, ...	1·216
32 ,, ...	1·224
33 ,, ...	1·231
34 ,, ...	1·238
35 ,, ...	1·245
36 ,, ...	1·252
37 ,, ...	1·259
38 ,, ...	1·266
39 ,, ...	1·273
40 ,, ...	1·280
41 ,, ...	1·287
42 ,, ...	1·294
43 ,, ...	1·300
44 ,, ...	1·307
45 ,, ...	1·313
46 ,, ...	1·319
47 ,, ...	1·325
48 ,, ...	1·330
49 ,, ...	1·336
50 ,, ...	1·343

Sodium bichromate decomposes at a temperature slightly above its fusing-point (320°). At about 400° it begins to give off oxygen, while at a temperature just below dull red heat the evolution of oxygen becomes almost violent, the salt decomposing into normal sodium chromate, chromic oxide, and oxygen.

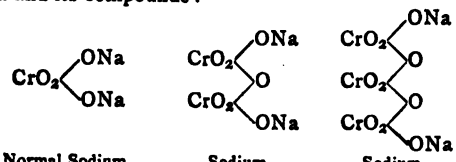
$$2Na_2Cr_2O_7 = 2Na_2CrO_4 + Cr_2O_3 + O_3.$$

Amongst the products of decomposition a small quantity of free alkali was found, produced, no doubt, by a slight decomposition of the chromate.

If sodium bichromate be dissolved in warm aqueous chromium trioxide, and the solution allowed to cool, crystals of a dark red colour are deposited. These yielded, on analysis, the formula $Na_2Cr_3O_{10}$, and were, therefore, sodium trichromate.

Calc. for $Na_2Cr_3O_{10}$ .. Cr = 43·09 p.c. Found 43·14 p.c.

This compound may be represented graphically by the following constitutional formula, the chromates and their derivatives being represented as containing the dyad radical, chromyl, CrO_2, analogous to the dyad radical sulphuryl, SO_2, whose existence is assumed in sulphuric acid and its compounds:—



Normal Sodium Chromate. Sodium Bichromate. Sodium. Trichromate.

The crystals of sodium trichromate are very soluble in water, and deliquescent.

By the action of sodium dichromate on cupric hydroxide, which has been freshly precipitated, I obtained a substance which, on analysis, yielded the formula—

$$Na_2CrO_4 + Cu_3Cr_2O_9 + 4H_2O, \text{ or}$$
$$Na_2CrO_4 + CuCr_2O_7 + 2CuO + 4H_2O.$$

	Theory.	Found.
Sodium	6·84 per cent	6·89 per cent.
Chromium ..	23·21 „	23·03 „
Copper	28·35 „	28·62 „
Water	10·73 „	10·84 „

It is thus a compound of sodium chromate with a basic copper dichromate, $CuCr_2O_7 + 2CuO$. This substance occurs as a brown powder, which consists of microscopic crystals. It is almost insoluble in water, and slightly soluble in alcohol. On heating, the four molecules of water are given off below 200°, leaving the anhydrous substance as a dark brown mass, which latter, on heating to a higher temperature, partially decomposes, becoming black, owing to separation of cupric oxide.

When a solution of sodium bichromate, which has been neutralised with magnesia, is evaporated, the double salt, magnesium-sodium chromate,—

$$MgCrO_4 + Na_2CrO_4 + 3H_2O,$$

crystallises cut in yellow four-sided prisms and plates. It is soluble in water and alcohol, but insoluble in ether. All the water of crystallisation is given off below 200°, leaving the anhydrous compound as a dark reddish brown powder. At red-heat it fuses and partially decomposes.

Sodium dichromate has an acid reaction, and by caustic soda or the carbonate is converted to the normal sodium chromate, but by heating with metallic sodium it is reduced to chromic oxide. It is a powerful poison, like the potassium salt, probably on account of its oxidising properties. Sodium bichromate also acts like the potassium salt in its action on organic matter. If a film of organic matter be saturated with a solution of sodium bichromate, on exposure to light it becomes of a dark colour, which is caused by a reduction to chromic oxide occurring. This property of the bichromates is applied in the arts in the autotype, and similar photographic printing processes.

The commercial salt is in some cases almost chemically pure; in others it is purposely made impure, owing to the fact that the purer it is the more hygroscopic it becomes. The fused varieties always contain a small percentage of chromic oxide produced by decomposition at the temperature of fusion.

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ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

1. *Introduction.*

It cannot be denied that the number of micro-chemical indications, of which we can avail ourselves in the study of minerals, to recognise certain constituents, is much less than those which serve to indicate the elementary substances of animal and vegetable tissues; and that the application of these last is much more extensive than that of the chemical reactions employed in divining the nature or composition of any mineral specimen.

It is evident that we cannot find the cause of this difference in the fact that the advantage of the micro-chemical analysis would be less when studying a mineral substance than when examining the nature of an animal or vegetable tissue. Indeed, those who have been engaged in the microscopic examination of minerals will agree that if it were possible to show, by micro-chemical means, the presence of potassium and sodium, and to estimate approximately the proportion of the constituents of felspar with the same facility and precision that can be obtained in finding and estimating starch by means of iodine, or cellulose with iodine and sulphuric acid, there would result a great gain to petrography.

For some time past it has been found necessary to extend and improve the methods of microscopic examination in the determination of the component parts of rocks. Mr. Zirkel made his first researches by means of ordinary light; a year later he made use of polarised light, and some years after that, in his researches on the basaltic rocks, he often had recourse to hydrochloric acid to enable him to distinguish labradorite from oligoclase, and magnesite from titaniferous iron. Since then hydrochloric acid has become the usual reagent for microscopists. However, it has latterly lost somewhat of its prestige, inasmuch as we became too exacting, and did not take sufficient account of its temperature and concentration, nor the duration of the reaction; and also by not making blank experiments to control the results.

Generally speaking, however, we make use of it on account of its decomposing and dissolving action; but it is only occasionally that we pay attention to some of the products of decomposition, such as carbonic acid as a sign of the presence of calcite, sodic chloride produced by the decomposition of nepheline, gelatinous silicic acid as an absorbent of the colouring matters, so that we can more easily recognise the easily decomposable silicates, like olivine, chlorite, &c.

Among the micro-chemical reagents which have lately become known we might mention the reagent brought out by Fresenius (ammonic molybdate dissolved in nitric acid), which was employed by Streng, in his research on apatite in rocks from various sources; the colouration by sulphur vapour of several mineral species belonging to the group of haüynite and its allies, according to the method followed by Knop; and the colouration of the different varieties of opal by the solution of magenta.

While the application of chemical reactions made only slow progress, the improvement of optical methods which

could serve in the study of minerals was attracting considerable attention.

We borrowed from the zoological and botanical microscopes the use of plates of gypsum and quartz, to increase the effect of double refraction, for rotating optical axes, and for distinguishing between positive and negative double refraction.

Soon the researches of M. Tschermak (1869) gave an impetus to the microscopic study of dichroism in minerals, at first by means of M. Haidinger's di-chroscopic lens, and afterwards by means of two Nicol prisms, and at last we owed to the researches of M. Descloiseaux* on the optical constants of felspar, the application of M. Kobell's stauroscope to microscopic work. Then M. Rosenbusch rendered essential service to the science in giving a more convenient form to the apparatus which was used for observations of this character (1876), and by publishing his Micrographical Manual, which contributed largely to the spread of the microscopic examination of minerals.

Mechanicians and opticians then came to our assistance by constructing and perfecting machines for cutting and slicing minerals, so that the preparation of thin and transparent plates of mineral substances became much less laborious, and we were enabled to make sections in any direction without trouble. At the same time microscopes and all their auxiliaries were improved. It is only just to mention the workshops of Fuess at Berlin, and Seibert Bros. at Wetzlar, as being those which gave the impulse in this direction.

(To be continued.)

FURTHER RESEARCHES ON COMPLEX INORGANIC ACIDS.†

By Dr. WOLCOTT GIBBS.

You will doubtless remember the very interesting and curious results obtained many years since by Schützenberger by the action of phosphoric pentachloride upon spongy platinum. We have simply $Pt+PCl_5=PtCl_2.PCl_3$, the compound by the action of water giving the corresponding acid $PtCl_2.P(OH)_3$. A second and analogous compound chloride has the formula $PtCl_2.2PCl_3$, and this yields the acid $P_2.PtCl_2.(OH)_6$. A third acid has the formula $P_2.PtCl_2.(OH)_5$, and a fourth is represented by $P_2O_2.PtCl.(OH)_3$. These compounds have attracted very little attention, perhaps on account of the neglect and contempt into which inorganic chemistry has fallen of late years. Schützenberger does not appear to have attempted to generalise his results. I have endeavoured to show, in a paper read before the National Academy of Science, that in Schützenberger's acids platinous chloride simply replaces an atom of oxygen, and that, by appropriate methods we ought to be able to perform the inverse substitution and obtain three new acids of phosphorus which would have respectively the formulæ $P_2O(OH)_6$, $P_2O(OH)_5$ or perhaps $P_4O_2(OH)_{12}$, and $P_4O_7(OH)_6$, since $2PtCl'''=3O$. Of course the first acid mentioned above, $P.PtCl_2.(OH)_3$, is, on this view, ortho-phosphoric acid, in which $PtCl_2$ replaces one atom of oxygen. I have now succeeded in generalising these results in what seems to me an interesting manner. In the first place I have discovered compound acids analogous to chlor-platin-ortho-phosphoric acid, which contains respectively palladium, iridium, ruthenium, and osmium in place of platinum. Want of material has prevented me from experimenting with rhodium also, but it can hardly be doubted that it forms similar compounds. In the next place I find that platinous chloride may be replaced by platinous oxide or bromide, and the same appears to be true for other metals of the platinum group. A still further generalisation consists in replacing phosphorus by arsenic and antimony, which is easily effected. It is to be expected that vanadium will yield similar compounds, but here again want of material has prevented the actual experiment up to the present time. The following formulæ, which are, I believe, to be depended on, will serve to illustrate my results—

$$As_2O_3.3[As_2O_3.2PtO]5(NH_4)_2O+7Aq,$$
$$[As_2O_3.2PtCl_2]K_2O\ 2H_2O.$$

As I have written it, the first compound might be called an arsenoso-oxyplatin-arsenate, and the second a chlorplatin-arsenate. When these compounds are digested or boiled with acid tungstates and molybdates, higher complex acids are obtained, which I am now studying. One tungsten compound appears to have the formula—

$$24WO_3.As_2O_3.3[As_2O_3.2PtCl_2]\,12Pt(NH_3)_4O+60Aq.$$

Another, the formula—

$$22WO_3.3As_2O_3.3[As_2O_3.2PtO]6Pt(NH_3)_4O+40Aq.$$

A beautiful pale green molybdenum compound has the formula—

$$12MoO_3.As_2O_3[As_2O_3.2PtO]2Pt(NH_3)_4O+27Aq.$$

All these compounds contain the oxide of platinoditetramine, $Pt(NH_3)_4O$, as a base. The formulæ given, however, are only preliminary, and may hereafter prove reducible to simpler expressions. The salts were obtained by digesting or boiling the green salt of Magnus, $Pt(NH_3)_4Cl_2+PtCl_2$, with arsenoso-tungstates and arsenoso-molybdates. Analogous series appear to be formed when arsenoso-phospho-tungstates and arsenoso-phospho-molybdates are digested or boiled with platinous chloride or with the tetramine salt. Now, replace platinum by other metals of the same group, and arsenic by antimony or phosphorus, perhaps also by vanadium, and you will have some idea of the extent of the new field of work in which I am now labouring as fast as my limited means and resources will permit.

THE ACTION OF REAGENTS ON COBRA-POISON.

By C. J. H. WARDEN, Surgeon, H M.'s Bengal Staff, Professor of Chemistry, Calcutta Medical College.

Preliminary Note—Action of Heat.

THE experimental inquiry, detailed in the following communication, has been undertaken at the suggestion of Professor Koch,* of Berlin, with the object of systematically ascertaining the action of reagents on cobra-venom. I am well aware that researches of a similar nature have engaged the attention of many workers, and it is, therefore, with hesitation that I venture to undertake the investigation of a subject which has hitherto proved so practically unfruitful. Numerous antidotes have been suggested, but one and all have failed when employed on the human subject, and this, no doubt, arises from the fact that conclusions have been hastily arrived at, rather than carefully and patiently worked out. On the other hand, any accurate information regarding the action of reagents on snake-poison—be the facts discovered ever so small or apparently trifling—is a step in advance, and one towards the solution of that most important problem, the discovery of a reliable mode of treating cases of snake-bite.

In investigations regarding the action of drugs of a complex nature, it frequently occurs that the physiological action of the drug, considered as a whole, differs from its

* Several papers in the *Comptes Rendus* and the *Annales de Chimie de Physique*, 1875 and 1876.

† From *American Chemical Journal*, Vol. VIII., No. 4.

* The experiments described in this note were performed in the Chemical Laboratory, Kaiserl. *Deutschen Reichs-Gesundheits Amt, Berlin.* I would take this opportunity of thanking Dr. Koch for his valuable advice in the conduct of my experiments, and Dr. Sell for permitting me to work in his laboratory.

isolated constituents. Thus, while opium is narcotic, thebaia, one of its constituents, is purely excitant, and in doses of one grain causes tetanic spasms (Farquharson). The experiments of Blyth, S. Weir Mitchell, and others, appear to indicate that snake-poison is a mixture of several toxic agents. According to Weir Mitchell the poison can be separated by dialysis into at least three proteid constituents. One, dialysable and resembling a peptone—"venom peptone" and apparently a hastener of putrefactive change, and a convulsive agent, but with little power to prevent coagulation of blood, and varying in different snakes. A second—"venom-globulin," a more deadly poison, acting powerfully on the blood and capillaries, so as to cause enormous local hæmorrhages at the point where the poison is injected. It was destroyed at 100° C. in all the venoms studied. The third proteid—"venom-albumin," resembles serum-albumin.

A research, therefore, of the nature I have undertaken includes experiments with the poison as a whole, and *secondly*, the action of reagents on its several principles. I propose dealing first with the venom considered as a whole, reserving until afterwards a consideration of its chemical composition, together with the action of reagents on its constituents.

In order to ascertain the influence of a reagent on the toxic power of snake venom, it is essential that the dose administered, admixed with the reagent, should be accurately the same as that employed in the control experiment, and *secondly*, that the quantity of venom should be the minimum dose which, with certainty, causes death. To administer an overwhelming dose mixed with the reagent and to expect any other than a fatal result appears to be futile, for even in the case of that small class of poisons for which we have antidotes the exhibition of a very large dose renders the operation of the antidote inutile.

The first question, therefore, which I attempted to solve, was the minimum fatal dose requisite for the class of animal selected for the experiments. This having been determined, the sample of venom was standardised. It need hardly be observed that in dealing with a toxic agent of such potency as cobra-venom, and one in which the line of demarcation between a fatal and non-fatal dose is so small, that this is a most important point.

In the experiments detailed in this note I have employed the dried venom, and it is perhaps preferable to the fresh poison, because, though the former may be somewhat less active, yet it is comparatively stable, and definite in composition, and a sample of one or two grms., after having been standardised, suffices for a large series of experiments. On the other hand, the fresh venom cannot be kept for any length of time without undergoing decomposition, the products of different snakes vary in toxic power, and hence to obtain comparable results, a number of standardising experiments are requisite. According to Wall—"Indian Snake-Poison"—specimens taken from several cobras and mixed, gave a specific gravity of 1058. On evaporation the fresh venom yields from 25 to 50 per cent of solid residue.

The cobra-poison used in this series of experiments was obtained from Prof. Koch, who had received it from Dr. V. Richards, of Assam. It consisted of two specimens, in the form of small, dry, transparent, yellowish fragments, one somewhat paler in colour than the other, but both having much the appearance of coarsely-pounded gum-arabic. In cold water—with the exception of a few small white flakes—the venom was readily soluble, yielding a very faintly acid solution, which frothed strongly on agitation, even in highly diluted solutions. Snake-venom, which has been dried by exposure to air, is usually considered anhydrous, or as only containing traces of moisture, but, as the following determinations indicate, a considerable percentage of moisture may be present. One of the specimens given me by Prof. Koch lost 16·26 per cent of water in the course of sixty-five days by being kept over concentrated sulphuric acid; a second sample obtained from Prof. Pedler, of Calcutta, lost under similar treatment 15·43 per cent in thirty days.

In all my experiments, unless stated to the contrary, white or piebald China mice were employed. The necessary dose of the poison, &c., was always injected under the skin of the back by a small hypodermic syringe, of one cubic-centimetre capacity, graduated into ten parts, the graduations being marked on the piston rod.

Experiments to ascertain the minimum fatal dose for mice.—0·01 grm. of cobra-poison containing 83·74 per cent of anhydrous venom was carefully weighed, and dissolved in 10 c.c. of distilled water at 15° C.; 1 c.c. of the solution, therefore, equalled 0·001 grm. or 0·00083 grm. of the anhydrous poison.

Exp. 1—Three mice injected—

(*a*) With 0·1 c.c. equal to 0·0001 grm. poison. Death in 36 minutes.

(*b*) With 0·3 c.c. equal to 0·0003 grm. poison. Death in 44 minutes.

(*c*) With 0·4 c.c. equal to 0·0004 grm. poison. Death in 33 minutes.

Mouse (*a*) weighed 14 grms. Ratio of poison to body weight, 1 to 140,000. In the case of mouse (*b*) part of the injection escaped.

Exp. 2.—As the solution used in the first experiment was evidently too concentrated, and as it was difficult to accurately inject more than 1 c.c., the solution was diluted with distilled water in the proportion of 1 to 9. One c.c. of the diluted solution was therefore equal to 0·0001 grm. of the poison. Three mice injected with the diluted solution:—

(*a*) With 0·1 c.c., equal to 0·00001 grm. Not fatal.

(*b*) With 0·2 c.c., equal to 0·00002 grm. Death in 1 hour and 50 minutes.

(*c*) With 0·4 c.c., equal to 0·00004 grm. Death in 58 minutes.

Exp. 3.—As a control experiment a fresh solution was prepared by dissolving 0·01 grm. in 100 c.c. of distilled water, and the solution filtered. Four mice injected—

(*a*) With 0·1 c.c., equal to 0·00001 grm. Not fatal.

(*b*) With 0·1 c.c., equal to 0·00001 grm. Not fatal.

(*c*) With 0·2 c.c., equal to 0·00002 grm. Death in 1 hour and 17 minutes.

(*d*) With 0·2 c.c., equal to 0·00002 grm. Lived over 3 hours.

Ratio of poison to body weight (*c*) 1 to 6,140,000 (*d*) 1 to 6,810,000.

In the case of (*d*) mouse part of the injection escaped, so that it received more than 0·1 c.c., but less than 0·2 c.c. Though life was prolonged for over three hours, the symptoms were most marked. Shortly after the injection the animal became restless; the breathing then became hurried, and accompanied every now and then by a squeak. Ultimately it fell on its side, and the respirations became gradually slower. There were no convulsive movements.

In the following table the results of the foregoing experiments are given in terms of anhydrous venom:—

(*a*) 0·000083 grm. Proved fatal in 36 minutes.
(*b*) 0·00025 grm. Proved fatal in 44 minutes.
(*c*) 0·00035 grm. Proved fatal in 38 minutes.
(*d*) 0·0000355 grm. Proved fatal in 58 minutes.
(*e*) 0·000016 grm. Proved fatal in 1 hour and 50 minutes.
(*f*) 0·000016 grm. Proved fatal in 1 hour and 17 minutes.
(*g*) 0·000016 grm. Lived over 3 hours.
(*h*) 0·000008 grm. Not fatal.
(*i*) 0·000008 grm. Not fatal.
(*j*) 0·000008 grm. Not fatal.

Dealing thus with quantities of the anhydrous venom varying between 0·000016 and 0·000008 of a gramme, we have a series of six results which indicate that while the first-mentioned amount is a non-fatal dose, double the quantity is certainly fatal. With the indication afforded by Exp. 3 (*d*) we are justified in assuming that for the

particular sample of poison employed the minimum fatal dose of anhydrous venom for a China mouse is more than 0·000008 and less than 0·000016 of a gramme.

(To be continued).

NOTICES OF BOOKS.

Descriptive List of Experiments on the Fundamental Principles of Chemistry. By J. Parsons Cooke. Cambridge: Harvard University. 1882.

The Introduction to this pamphlet contains some good sound advice to students of chemistry, in which we note several rules which were laid down by W. R. Nichols and L. M. Norton in a pamphlet entitled "Laboratory Experiments in General Chemistry." These rules impress strongly on the student or operator the necessity of taking full and careful notes of all experiments *at the time*.

The first part of the pamphlet is devoted to a description of the properties and character of the different elements, with full directions for determining them: for example, under "Sulphur," we find—"The student should be given a roll of brimstone, and asked to study and describe its distinguishing properties, including colour, hardness, tenacity, specific gravity, fusibility, volatility, colour of vapour, and solubility in ordinary solvents." This method of making students thoroughly acquainted with the various chemicals they will have to deal with is undoubtedly better than the method which has been adopted of late years, of giving only a superficial knowledge, which can be quickly picked up, but alas! easily forgotten.

The second part is headed "General Principles," and the third treats of molecules and atoms. The definition here given of an atom of hydrogen is "the smallest mass of matter recognised by Science."

Part IV. is devoted to symbols and nomenclature; Part V. to molecular structure; and Part VI. to thermal relations, such as the heat of solution, precipitation, or chemical action.

This pamphlet promises to be exceedingly useful to beginners, and is evidently meant to teach and not to cram.

Analysis Tables for Chemical Students. By R. L. Taylor, F.C.S., F.I.C., Teacher of Chemistry and Physics in the Central Higher Grade Board School, Manchester. London: Sampson Low, Marston, and Co.

These tables are in their object essentially examinational. Both the title-page and preface inform us in substance that they are principally "for the use of students who are working for the advanced stage of the Science and Art Department examinations in practical inorganic chemistry and both the elementary and advanced stages of practical organic chemistry."

We have here doubtless the reason why so many of the metals, including, *e.g.*, the two platinum groups, are omitted, and why silicic and manganic acids do not figure among the list of inorganic acids.

The instructions in practical organic chemistry are limited to tests for the recognition of nine organic acids, including the salicylic, but excluding the tannic and gallic! For this curious selection Mr. Taylor cannot, indeed, be held in any way responsible. Like other science teachers he must, to a great extent, shape his course according to the winds blowing from South Kensington.

The reactions given are all, as far as we have been able to perceive, accurate; but the omissions and limitations which we have pointed out must greatly interfere with its usefulness to students not working on the lines of the Department. To take a single instance: in the table for testing for acids we are told that on adding hydrochloric acid to a substance and heating, the evolution of chlorine "indicates a chlorate or a chromate." True, but it may also indicate a permanganate. Thus these tables are trustworthy only if the student knows that no substance is present save those which will be submitted to him at the Departmental Examination.

Laboratory Calculations and Specific Gravity Tables. By John S. Adriance, A.B., F.C.S. New York: John Wiley and Sons.

We have here an exceedingly useful selection of tables, which will certainly, as the author hopes, save both the student and the analyst much tedious calculation.

The table of atomic weights shows the values as recalculated by Prof. F. W. Clarke, and includes such of the rarer metals as have been satisfactorily determined. Next follows a table of conversion-factors, commonly used in analysis.

There is a table of the absorption of carbonic acid in 5 c.c. of hydrochloric acid, at 1·125 sp. gr., for evolutions of between 1 and 100 c.c. There follow next tables of the weight of 1 c.c. of carbonic acid at different temperatures and pressures; of the absorption of nitrogen gas in hypochlorite solution; weight of 1 c.c. nitrogen for variations of temperature and pressure; table for converting nitrogen into ammonia; tensions of aqueous vapour for temperatures from −2° to +110°; molecular weights, and weights of 1 litre of gases; and Beaumé's hydrometer scale for liquids heavier and lighter than water. Here we must speak guardedly; for although this scale is perfectly arbitrary, and exists in two, if not three, discrepant versions, and though the indications of the instrument cannot be translated into direct specific gravity by any simple calculation, yet were we to state the conviction that Beaumé ought to be discarded in favour of Twaddle we should perhaps find ourselves involved in a prolonged controversy.

Next follow the tables of Fownes and Gay-Lussac, giving the proportion of actual alcohol in 100 parts of spirits of different specific gravities. There are then factors for determining quantity of pure sugar by Ventze's and Duboscq's saccharometer; tables showing the percentages of the most important acids in aqueous acids of given specific gravities; similar tables for ammonia, soda, common salt, potash, calcium, barium, magnesium, aluminium, ammonium, copper and stannic chloride solutions, specific gravities, and percentages for solutions of a number of salts often met with in manufacturing operations; comparisons of thermometer scales from 100° down to −34·4°; comparative table of barometer indications in inches and millimetres; comparison of air and mercurial thermometers; conversion of column of water into column of mercury; and tables of weights and measures. Here we meet with an apparent discrepancy. A pint is said (p. 69) to be equal 0·567636 litre, whilst on the next page it is said to contain only 0·473148 litre. Possibly the last-mentioned figures may refer to the old "wine-measure," which, we believe, is still current in the United States.

Concerning the value of this book in the laboratory no two opinions can prevail.

Universal Pharmacopœia. (*Universal Pharmakopöe*). A Comparative Conspectus of the Pharmacopœias at present valid in Europe and North America. By Dr. Bruno Hirsch. Vol I. Leipzig: Günther. London: Williams and Norgate.

Dr. Hirsch has evidently expended a great amount of time and labour in the compilation of the work before us, and is entitled to the gratitude of pharmacists and medical practitioners. His object is to pave the way for a universal pharmacopœia to be recognised among all civilised nations. He hopes that the collocation which he is carrying out

will render it easier in the future to pick out the best features from every national pharmacopœia, and unite them into a totality preferable to anything which has yet appeared. This, he is fully aware, will be no easy matter; the crude drugs accepted in one country are rejected in another. The methods of preparation and the tests for purity and quality are also far from identical. The weights and measures employed vary, as do also the thermometer and hydrometer scales. The languages, too, differ. The pharmacopœias of Austria, Prussia (V., VI. and VII. editions), Denmark (with a Danish supplement), Fennica (Finland?), Germany (1st ed.), Switzerland, Holland, Norway, and Sweden, are drawn up in Latin; the second edition of the German pharmacopœia is in Latin and German, the Latin being, as we are here informed, in part a mistranslation from the German; the Belgian is in Latin and French; the Greek is Latin and modern Greek with a Greek supplement; the Hungarian is written in Latin and Magyar; the British and the United States pharmacopœias are in English; that of France in French; and those of Roumania, Russia, and Spain in their own respective languages. Still, notwithstanding this diversity of tongues, we might expect the nomenclature both of plants and of chemical compounds to be approximately identical. Such, however, is far from being the case. The Spanish, and to some extent the French, pharmacopœia retain fragments of the terminology of the præ-scientific ages. The chemical nomenclature used by German pharmacists is very distinct from that employed in pure or in technical chemistry. Thus the reader would be apt to think that ferrum chloratum, bromatum, iodatum, &c., must mean iron chlorate, bromate, and iodate. But, on the contrary, these terms are applied unhappily, as it appears to us, to the chloride, bromide, and iodide. Further the term chloral is as well known in Germany as in England, but pharmaceutically speaking it receives the termination *um*, and figures as "chloralum."

This actually at one time was the cause of a misunderstanding and controversy. A company was at one time largely manufacturing and exporting aqueous aluminium chloride, under the name of "chloralum," for disinfecting purposes, and a German paper assumed that the agent used was a solution of chloral.

We find in this work no reference to an Italian or a Portuguese pharmacopœia.

Exercises on Mensuration for Junior Students. By T. W. K. Start, Assistant-Master at the Manchester Grammar School. London: Sampson Low, Marston, and Co.

This pamphlet scarcely falls within the class of works of which we usually take cognisance. It is, however, undeniable that the ability to deal with such questions as are here given would be of great value to managers, foremen, &c., in chemical works.

CORRESPONDENCE.

ANALYSIS OF IRON.

To the Editor of the Chemical News.

Sir,—May I be permitted to say that I think Mr. Deane (Chem. News, vol. liv., p. 174) greatly underestimates the experience of the analysts engaged in our Iron and Steel Works. With regard to the separation of the silica from the solution of ore, pig, &c., in the gravimetric estimation of manganese, I have not heard of one analyst engaged in this class of work who would neglect such an obvious precaution. I know that I have not made such an estimation otherwise for ten years. And not only this, but as a rule the Mn_3O_4 is carefully examined and any impurities found therein deducted. Volumetric methods, however, have, to a certain extent, done away with these tedious precautions, which are absolutely necessary for even a fairly accurate result.

In the estimation of phosphorus, where the precipitation by ammonium molybdate is made directly in the HCl solution of ore, metal, &c., it is my own practice, and that of most, if not all, analysts of my acquaintance, to have a measured excess of acid. To the HCl solution excess of NH_3 is added, then HNO_3 till the precipitate just dissolves, then a measured quantity of HNO_3. The bulk of liquid, of course, is likewise measured.

The well-established efficiency of ammonium nitrate in hastening and completing the precipitation is evidently unknown to Mr. Deane.

I also notice that, although he gives the quantity of molybdate solution he uses, he omits to mention the strength of the solution, which is perhaps the most important point of all.—I am, &c.,

T. Jobson, Jr., F.I.C.

Stocksbridge Works, Sheffield,
October 6, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ciii., No. 11, September 13, 1886.

Experiments on the Electro-Conductivity of Gases and Vapours.—Jean (probably Giovanni) Luvini.—The author's experiments lead to the conclusion that gases and vapours, under whatever pressure and at whatever temperature, are perfect insulators, and that they cannot be electrised by friction either among themselves or with solids or liquids. All theories relating to the electricity of machines, of the air, or of clouds, must be rejected as erroneous if it is admitted in them that moist air is a conductor, or that gases and vapours may become electrised by friction.

Determination of Dry Extract in Wines.—E. Bouilhon.—Every augmentation of surface, *e.g.*, by the addition of porous bodies, reduces the weight of the residue in notable proportions in consequence of the evaporation of a part of the glycerin. To obtain comparable results chemists ought to use a capsule with a flat bottom, of a standard diameter, placed quite level under the receiver of the air-pump, and containing always the same volume of wine.

No. 12, September 20, 1886.

Modern Kinetics and the Dynamism of the Future.—G. A. Hirn.—In a recent work bearing the above title the author presents in an accessible form all the arguments which render henceforth untenable the kinetic theory of gases, which refers the majority of the properties of these bodies to molecular movements. Among the arguments brought forward there are, says M. Hirn, at least three of such a kind that we shall one day be astonished how physicists have been, for a single instant, able to accept the kinetic theory of gases. The kinetics of gases might be correct without it following that light, radiant heat, electricity, magnetic attractions and repulsions, and gravitation are due to movements of ponderable matter, and still less that our thought is merely a molecular movement. But the converse is not true, and with the kinetic theory of gases fall the kinetic theories in general, which profess to explain all the possible phenomena of the universe by the invisible movements of matter. Two grand propositions confront each other in absolute antagonism.

According to one the movement of matter can arise only from another anterior movement and by immediate contact; according to the other motion never arises directly and by the immediate contact of matter and matter. The author contends that these two propositions, mutually exclusive, repose not upon metaphysical considerations, but upon the principles of applied and elementary mechanics; the demonstration of the one to the exclusion of the other is not to be banished to the land of dreams and chimeras, but is within the reach of all who occupy themselves with the reality of phenomena rather than with their *à priori* interpretation. The first proposition, and consequently all possible kinetic theories of which it is the starting point, fall with the kinetic theory of gases.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xv., Part 5.

Researches on the Proportion of Carbonic Acid in the Air.—W. Spring and L. Roland.—The air of Liege is exceptionally rich in carbonic acid, containing 0·05126 per cent by weight or 0·03353 by volume, as against 0·0483 and 0·03168 found in the air of Paris. The authors suggest that the cold weather of the earlier part of May may be due to a temporary decrease of atmospheric carbonic acid, occasioned by the demands of vegetation. In calm weather the air is, in the mean, poorer in carbonic acid than during strong winds.

Removal of Micro-organisms from Water. — P. Frankland.—From the *Proceedings of the Royal Society*.

Self-Purification of Foul Waters. — Prof. Alex. Müller.— The author observes that urine diluted with 100 parts of water is rapidly oxidised. Sugar, alcohol, and acetic acid check nitrification.

A Novel Theory of the Nutrition of Plants by Means of Fungi in the Soil.—Prof. Frank.—The author holds that the roots of most forest trees, oak, beech, birch, alder, and all the conifers have, in contradistinction to other trees, their roots clothed with a dense stratum of fungi, the capillary roots which, in other plants, effect the absorption of water and nutriment being entirely wanting. He considers that the fungus threads replace the capillary rootlets and mediate a direct assimilation of humus.

Hohenheim Manurial Experiments.— Prof. Strebel. —We find mention here of a "cock-chafer manure" prepared by Wolff and Sons, of Heilbronn. Its composition is not stated.

Use of Sugar in Feeding Fat Oxen and Young Cattle.—Prof. Holdefleiss.—One cwt. raw sugar seems to have been utilised to the value of 10s., which cannot be considered remunerative. Young cattle which received rations of sugar were injured in their health.

"Mal-Rouge" in Swine.— Schütz.— Swine can be protected against this disease by means of Pasteur's vaccine.

Determination of Metamorphotic Products in Animal Dung. — Dr. Pfeiffer. — Not suitable for abstraction.

Formation and Migration of the Carbohydrates in the Leaves of Trees.—A. F. W. Schimper.—The mesophyll and the sheath cells exert an unequal attraction for dissolved carbohydrates.

Fluctuation of the Respiration of Plants.—G. Bonnier and L. Mangin.—From the *Comptes Rendus*.

Inequalities in the Composition of Gases in Leaves Exposed to Air.—S. Peyron.—From the *Comptes Rendus*.

Activity of Chlorophyll in Ultra-violet Darkness.— G. Bonnier and L. Mangin.—From the *Comptes Rendus*.

Quantities of Heat Liberated and Taken up by Plants.—G. Bonnier.—From the *Comptes Rendus*.

Composition of Potatoes when not Fully Ripe.— F. Hungerbuehler.—As ripeness progresses the proportions of starch and of non-albumenoid nitrogen increase, whilst that of albumenoid nitrogen decreases.

Application of a Mixture of Quicklime and Blue Vitriol against Mildew in Vines.—E. Prillieux.—The results were generally found satisfactory. The proportions used were 25 kilos. copper sulphate in 225 litres water and 25 kilos. quicklime.

Copper contained in Vines treated with the Mixture of Lime and Copper.—A. Millardot and U. Gayon. —The wines contained traces of copper doubtful or too small to be determined. The maximum was 0·1 grm. in 100 litres.

Action of Pasteurising upon Milk. — Dr. J. Van Geuns.—This process consists in heating the milk for a short time to 62°. By this means the lactic fermentation is retarded for some days. By far the greater number of the microbia are killed.

Classification of Wines.—A. W. von Babo.— The author divides wines into six classes:—(1) "Ausbruch" wines (a kind for which there is no English name); they are so concentrated that a complete decomposition of the sugar into alcohol and carbonic acid cannot take place, much of it remaining in the wine unchanged. Such wines contain little acid, a high proportion of extract, and not more than 14 to 15 per cent of alcohol. (2) Liqueur wines are those where the complete decomposition of the sugar is prevented by the direct addition of alcohol. They contain 18 to 24 per cent of alcohol and a less proportion of extractive matter than do the Ausbruchs. (3) Bouquet wines are of an acidulous flavour, and in them a normal decomposition of the sugar has taken place. Their value depends on ethereal compounds. The celebrated products of the Rhine district belong to this group. (4) Heavy table wines have a full flavour without sweetness. They have little acidity. The Austrian and (ordinary) Hungarian wines belong here. (5) Light dinner wines. They contain little acidity and are not strongly alcoholic. They are of great importance in commerce, but rarely receive prizes at exhibitions. (6) Labourers' wines with little alcohol and extractive, but much acid. Petiotised wines fall in this section.

New Experiments on the Fermentation of Urine. —Prof. A. Müller. The author ascertains the action of a number of substances n promoting or retarding the fermentation of urine. It appears that potassium permanganate promotes fermentation, whilst potassium chlorate delays it.

Preservation and Disinfection of Blood.—Prof. A. Müller.—The author recommends peat-mull and lime for working up blood into manure. Manganese chloride and hydrochloric acid are less efficacious in preventing nuisance than free sulphurous acid. Sulphites are less efficient.

MISCELLANEOUS.

Science Works.—We have received from Mr. W. F. Clay, of Edinburgh, two catalogues of standard scientific books which appear to be offered at very cheap prices, and we should advise those of our readers who want an opportunity of stocking their libraries to send for these catalogues. More than ordinary interest will be attached to many of these works from the fact that they formed a portion of the library of the late Dr. Henry Watts, F.R.S.

Prize to Chemists.—The money prize open for competition three months ago, by the Canadian Meat Company, of Liverpool, London, Montreal, Chicago, Boston, and New York, has been awarded to Dr. A. B. Griffiths, F.R.S. (Ed.), F.C.S. (Lond. and Paris), Head Master and Lecturer on Chemistry, School of Science, Lincoln, and to Baron Romburg,—for their essays on the scientific and medical value of the Company's "Extract of Beef."

TO CORRESPONDENTS.

Ignoramus.—Certain experiments have been lately made under the direction of Prof. Holdefleiss (*Organ des Central Vereins für Rüben Industrie der Oester. Ungar. Monarchie*, vol. xxxiii., p. 779). A number of bullocks were fed with a diet of beets, clover and lucerne, hay, rye and barley-straw, rape-cake and bran. Two of them received in addition 0·75 to 1 kilo. sugar daily. The average increase of weight in those receiving the sugar was 157·5 kilos in 114 days, whilst those without sugar increased on the average only 102 kilos. in the same time.

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Assistant.—Mr. C. ELLIS, F.C.S.

ALEX. MOORE, C.A., Secretary.

Glasgow, 209, West George Street,
September, 1886.

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THE CHEMICAL NEWS.

Vol. LIV. No. 1404.

ON THE MAGNETIC ROTATION OF MIXTURES OF WATER WITH SOME OF THE ACIDS OF THE FATTY SERIES, WITH ALCOHOL, AND WITH SULPHURIC ACID, AND OBSERVATIONS ON WATER OF CRYSTALLISATION.*

By W. H. PERKIN, Ph.D., F.R.S.

From the author's previous work on the magnetic rotation of compounds it was found that the molecular magnetic rotation of water, which is taken as unity, is not the same as the sum of the values of oxygen and two of hydrogen, as deduced from the molecular magnetic rotation of other bodies. Thus hydrogen is found to be 0·254, whilst hydrogen in hydroxyl varies from 0·194 in ordinary alcohol to 0·137 in monobasic acids, and is 0·261 in carbonyl, so that taking the lowest number it gives $H_2+O=0·645$, and taking the highest it is 0·769.

From these facts it appeared that the determination of the magnetic relation of hydrated bodies might give numbers which would show whether they contained water, or whether the substances with which it was mixed had combined so as to form new compounds. If the former were the case the molecular rotation should represent that of the compound + that of water; if the latter, it should be lower than this: for example, if formic acid were mixed with water, molecular proportions being used, either $H.COOH+H_2O$ or $H.C(HO_3)$ might be produced. In the first case the rotation should be—

Formic acid	1·671
Water	1·000
	2·671

In the second, taking the highest value of H_2+O, it would be—

Formic acid	1·671
Water	0·769
	2·340

which is considerably lower.

As some of the fatty acids have been believed to unite with water, to form trihydric alcohols, they were selected for examination, and at the same time hydrated alcohol was also examined, because it could not form a compound with water, and would therefore act as a check upon the results.

The results of the examination show that formic, acetic, and propionic acids, when mixed with water, do not form new compounds, but that the products simply consist of these bodies and water.

Sulphuric acid in the pure and its hydrated conditions was next examined, viz., H_2SO_4, $H_2SO_4+H_2O$, $H_2SO_4+2H_2O$, and $H_2SO_4+3H_2O$. The numbers obtained in this case show that combination takes place chiefly when one molecule of water has been added only to a small extent in the case of the second addition, and scarcely any when the third is added; and the author gives reasons for considering that sulphuric acid combines with one molecule of water only, forming the compound $(HO)_4SO$.

Whilst studying the nature of the hydrated products, the author's attention was drawn to the subject of water of crystallisation, and from the inconsistency as to the presence or absence of water of crystallisation in compounds of the same class,—as, for example, in those of silver, potassium, and sodium, and also methyl bromide as compared with analogous compounds,—he considers it impossible to believe that water of crystallisation has any relationship to chemical combination; that of course refers to water when it exists as such, and not to hydrogen and oxygen present in the proportions found in water but otherwise combined. If this be so, it is thought that its association with chemical compounds is most likely connected with the building up of the crystalline form, it being difficult to see what other part it can play; and the reason why some compounds crystallise without and some with water of crystallisation is probably determined by the tendency to produce that form which can be the most readily built up; if that can result from the anhydrous salt, anhydrous crystals are formed; if with the salt and water, then it will contain water of crystallisation; and it is well known how change of conditions will cause variation in the proportions of water of crystallisation, and also form of crystal.

These observations would also apply to compounds crystallising with alcohol, acetic acid, benzene, &c., and to some double salts where one or more of the constituents would act like water of crystallisation. Attention is drawn to the fact that if the above view of water of crystallisation be correct, it is evident that a salt containing water of crystallisation will be resolved into water and the salt on breaking up of the crystalline form by solution, which is believed to be the case by many who have studied the subject of solution.

* Discussion on the "Nature of Solution," British Association, Birmingham Meeting, Section B.

ON THE NATURE OF LIQUIDS.

By WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc.

We read a short paper with the above title to the Chemical Society last June, embodying certain results which we had obtained during the past few years; and as our conclusions have, since the presentation of that paper, received striking confirmation by the Natansons, during a research on the vapour-densities of nitrogen peroxide, it appears to us advisable to bring these results before the Association as a contribution to the discussion on "Solution;" for it is evident that no theory of solution can be more than tentative which is not based on some definite conceptions of the actual nature of the menstrua in which solution takes place.

There will shortly appear, in the *Philosophical Transactions of the Royal Society*, a memoir on the behaviour of alcohol when heated. In this memoir we give data which we have deduced:—the expansion of liquid alcohol, between the temperatures of 13° and its critical point 243·1°; the compressibility of the liquid at various temperatures; the density of the unsaturated and saturated vapour; the vapour-pressures, from which have been calculated the values of increase of pressure for unit rise of temperature at certain definite intervals of temperature; and from these data the heats of vaporisation of the alcohol have been calculated. Last May a paper embodying similar results was read before the Royal Society, on ethyl ether; and a paper has recently been published in the *Transactions* of the Chemical Society on acetic acid. We have since finished a similar research on methyl alcohol, and we propose to extend this inquiry to the homologous alcohols.

The chief point which we have to deal with here is the densities of the saturated vapours of these bodies, at definite intervals of temperature, for from these data our deduction as to the nature of liquids is drawn.

* Discussion on the "Nature of Solution," British Association, Birmingham Meeting, Section B.

Now we find that the density of the saturated vapour of ethyl alcohol, of methyl alcohol, and of ethyl ether, under a pressure of 760 m.m., is somewhat greater than that deducible from their molecular formulæ. This is no new discovery; it has been long known that the density of a vapour near its condensing-point was somewhat abnormal. It has been investigated for water by Fairbairn and Tate, and for some other liquids by Schoop. But it has, we think, not been previously noticed that with such liquids, the chemical nature of which would not lead us to conjecture the union of their simple gaseous molecules to form a complex molecule, the density of the saturated vapour decreases with fall of temperature, and corresponding fall of pressure; and indeed becomes normal, and calculable from the respective molecular formulæ, at a pressure of about 200 m.m. Again, with rise of temperature, and corresponding rise of pressure, the density of the saturated vapour of such bodies rises, and, increasing with regularity, becomes at the respective critical points equal to that of the liquid, which has been enormously expanded by rise of temperature. If density be mapped on curve-paper as ordinates, and pressure as abscissæ, the relation of the saturated densities of such liquids is represented by a regular curve, the region where double flexure occurs being at a pressure of about 1000 to 5000 m.m., the temperature depending naturally on the nature of the liquid.

As we have remarked, we have also investigated within wide limits the changes produced by heat on acetic acid. The critical temperature of acetic acid lies too high for accurate measurement with the means at our disposal. But we have traced the relation of pressure to density so far as to show that with rise of pressure, and corresponding rise of temperature, the density of the saturated vapour is increasing rapidly. The limit of temperature employed by us was 280°. The isothermal representing densities of the unsaturated vapour at that temperature shows a little increase of density from a little above the normal density (30, where H = 1) at pressures below one atmosphere to 25,000 m.m., when the pressure is equal to that of the vapour in contact with liquid. It cannot be doubted that had we had the means of employing still higher temperatures, we should have found the density of the saturated vapour increase until the critical point was reached. With fall of pressure the density of the saturated vapour decreases, until at 140° the vapour is about fifty times as heavy as hydrogen under the same conditions of temperature and pressure. Little change takes place during a considerable fall of pressure, but at a certain pressure—corresponding to a temperature of about 120° to 130°—the vapour-density begins evidently again to *rise*, and continues to increase with fall of temperature and pressure, until at 50°—the lowest temperature and pressure at which we were successful in measuring this quantity—it had risen to 57 to 58.

Here we have a striking difference between ethyl alcohol, ether, and methyl alcohol, on the one hand, and acetic acid on the other.

These results have been confirmed by work which has lately been published by the Natansons. By a very ingenious method they have investigated the density of the unsaturated vapour of nitric peroxide. As these results have not been published in English, it may be advisable here to give some of the figures which they quote, transferring, however, their numbers, which refer to air as unity, to the basis of hydrogen. They give an isolated observation at −12·6°, and seven isothermals at 0°, 21·0°, 49·7°, 73·7°, 99·8°, 129·9°, and 151·4°. This limit of pressure was 800 m.m. Now the boiling-point of nitric peroxide at 760 m.m. is from our measurements (*Phil. Trans. Royal Society*, in course of publication) 21·8°, and the densities of the saturated vapour are deducible only from the first three of his isothermals. We have plotted their results on curve-paper: this has shown the great regularity and trustworthiness of their observations; and by continuing the curves in the direction in which they run, until they intersect the straight lines denoting vapour-pressures at the temperatures at which their measurements were made (using for this purpose the vapour-pressures determined by us), the density of the saturated vapour is determined with but small error.

The Natansons' numbers are as follows:—

Temp.	Press.	Density.	Temp.	Press.	Density
−12·6°	115·4	52·54	21°	491·6	38·74
0·0	37·96	35·84		516·96	39·01
	86·57	38·59		553·50	39·15
	172·48	40·71		639·17	39·64
	250·66	41·90			

At −12·6° the vapour-pressure of nitric peroxide is 125 m.m.; it must therefore nearly represent the density of the saturated vapour. At 0° the vapour-pressure is 255 m.m.; again the density found by Natanson must be nearly that of saturation. At 21° the vapour-pressure is about 700 m.m., and a prolongation of the curve constructed from the above numbers would cut the horizontal line representing the large alteration of volume with no rise of vapour-pressure, at a vapour density of about 40. It is evident therefore that with nitric peroxide, as with acetic acid, the density of the saturated vapour increases with fall of pressure and temperature. Now it is known that nitric peroxide dissociates, for the physical properties (colour, &c.) change, on change of N_2O_4 into $2NO_2$, and the similarity of behaviour between nitric peroxide and acetic acid renders the dissociation of acetic acid from $(C_2H_4O_2)_n$ into $nC_2H_4O_2$ no longer conjectural.

We have, then, to consider what reason can be ascribed to account for this behaviour. All liquids, dissociable or stable, show an increase in the density of their saturated vapours above a certain pressure and temperature, differing, of course, for each liquid. Some liquids, known to be dissociable into simpler molecules, show an increase, both on rise and on fall of temperature and pressure, above and below a certain temperature and pressure peculiar to the liquid. Now it is known that a high temperature favours dissociation. Hence it may be expected that the increase of the density of the saturated vapour universally observed at high temperatures should be explicable not on the hypothesis that such high pressures promote combination, because the corresponding high temperature would be extremely unfavourable to combination, but on the theory that, in spite of the tendency of the high temperature to separate the molecules from each other, they are nevertheless forced into close proximity by the corresponding high pressure. On the other hand, a low temperature is known to favour stability. Hence bodies consisting of molecules capable of chemical combination with each other, such as nitrogen peroxide and acetic acid, might be expected to give, as they do, evidence of such combination at low temperatures, in spite of the corresponding low pressure. It is impossible to conclude that the same effect should be produced, as it were, at each end of the scale of temperature, under such totally opposite conditions, by the same cause; and, inasmuch as bodies—such as ethyl and methyl alcohol and ether—exhibit no trace of such increase of the density of the saturated vapours with fall of temperature and pressure, it must, in our opinion, be concluded that the difference between gases and liquids lies merely in the relative lengths of the free paths of the molecules in the two states, and that, provided temperature and pressure are both sufficiently low, the body assumes the liquid form, and exhibits surface tension and cohesion, owing to the attraction of any one molecule for every other molecule,—not of any definite set of molecules for each other, which would result in the formation of a complex molecule. In short, the molecules of stable liquids exhibit physical attraction and not chemical attraction; the molecules of dissociable liquids exhibit *qua* liquids physical attraction, but they also exhibit chemical attraction, inasmuch as they tend to unite in pairs, or perhaps in simple groups.

We have another argument which goes far to prove this theory. If, at any given temperature, the relations between pressure and density of the unsaturated and saturated vapour of a stable substance be followed out, it has been found by us that the moment liquid is visible, at that moment the pressure is the vapour-pressure corresponding to the temperature; but on the contrary, with acetic acid, liquid may be present in a condensed form in small amount, and yet the pressure continues to rise with decrease of volume and corresponding condensation of more liquid. This can easily be explained on the supposition that the body under experiment is not homogeneous. With a little condensed liquid present the molecules of higher molecular weight are partially condensed out, and the vapour remaining retains proportionally more of the body with lower molecular weight, which may well be supposed to possess a lower boiling-point, or, in other words, to exert a higher pressure at any given temperature. Condensation proceeds, the condensed body consisting largely of the more complex molecules, and hence pressure rises correspondingly. The case is somewhat analogous to the compression of a mixture of the vapour of a stable substance with such a gas as hydrogen; but of course this instance exhibits this behaviour on an exaggerated scale. The data given in our paper will prove satisfactorily the complete absence of air and impurity, which, of course, would produce a similar result. It may be therefore concluded that, as stable liquids show no sign of this behaviour, their molecules show no tendency to combine so as to form complex molecular groups.

It is of course still open for any one to state that when the vapours of stable liquids condense, combination to form complex molecular groups, or chemical combination, occurs *precisely at the moment of condensation*. This we have not absolutely disproved; but we think that the foregoing experiments render such a hypothesis, to say the least, improbable, and the onus of proving it must be borne by those who would make the assertion.

Last year we made some experiments with the view of testing solubility in a fluid above its critical point. It will be remembered that some years ago Mr. J. B. Hannay worked at this subject, and stated that the fluid retained the power of dissolving solids; that on compression the solvent power increased; and that on warming evenly, so as to rarify the fluid, the solid was deposited. In our experiments the solid employed was eosine, and the liquid was alcohol. It is well known that a solution of eosine has a given fluorescence, whereas the solid is a dark red substance. It was supposed that the state of solution could be tested by the permanence of the fluorescence. We noticed that the fluorescence notably decreases at temperatures approaching the critical point; but that it is still permanent, at least for a short time, at temperatures a little above the critical point, and at volumes smaller than the critical volume. The difficulty of observation is, however, so great that we cannot positively state whether the solid is permanently retained by the fluid above the critical point; our impression is that after some time it is wholly deposited as a solid on the walls of the tube. It is extremely difficult to detect fluorescence in a tube the sides of which are coated with a translucent red deposit. From our view of the nature of liquids it is to be expected that solution should continue above the critical point, provided the volume is sufficiently small.

The Butylic Ethers of the Mono- and Dichloracetic Acids.—G. Gehring.—Butyl monochloracetate is a colourless, very mobile liquid, of a pleasant fruity odour and a burning taste. It dissolves in alcohol in all proportions and is sparingly soluble in water. Its sp. gr. at 0° is 1·103, and at 15° 1·081. The dichloracetate is colourless and very mobile; its odour is less pleasant than that of the corresponding mono-compound, and its taste is scarcely burning. It boils at 184°, and its sp. gr. at 0° is 1·182 and at 15° 1·169.—*Bull. de la Soc. Chim. de Paris.*

ON THE

ACTION OF HYPOCHLOROUS ANHYDRIDE ON IODINE TRICHLORIDE.

By H. BASSETT and E. FIELDING.

The following experiments were undertaken for the purpose of testing the possibility of a direct combination of the two reagents, which might have led to the formation of an oxychloride of iodine corresponding to pentabasic periodic acid.

The reaction taking place, however, is totally different, but we considered the results obtained of sufficient interest to be recorded.

The first experiments were made as follows:—

Two grms. iodine dissolved in 10 c.c. tetrachloride of carbon, and dry chlorine passed into it till saturated, when ICl_3 was deposited as an orange-coloured powder. In another bottle was placed 4 grms. dry precipitated mercuric oxide, covered with 30 c.c. CCl_4, which was then also saturated with dry chlorine, with frequent agitation. After standing a short time to settle, the clear liquid was poured into the solution of ICl_3, when an abundant flocculent precipitate was produced, of a light buff-colour, and the ICl_3 gradually disappeared on agitation. After a time the precipitate collected at the bottom, leaving the solution only slightly coloured. Similar results were obtained when the experiment was made in a different way, *i. e.*, by passing a slow current of Cl_2O through the solution of ICl_3.

A stream of dry air was then passed through the bottle, at first cold, till the excess of Cl_2O was expelled, and then heated to 100°, or rather more, when the CCl_4 slowly distilled off, together with orange-coloured vapours of chloride of iodine, at last leaving a buff-coloured, solid, powdery residue. Heated strongly in a tube this substance gave off at first a small quantity of reddish vapour, and at a still higher temperature a large quantity of iodine sublimed, and the tube was found to be full of oxygen.

Several analyses of the substance prepared in this way gave results indicating that the main product of the reaction is iodic anhydride, retaining, however, varying quantities of ICl_3.

We may here suggest that the above-mentioned solution of Cl_2O in CCl_4 may perhaps find applications in other cases.

We then tried the action of gaseous Cl_2O on the solid ICl_3, in the following way:—Chlorine, dried by H_2SO_4 and $CaCl_2$, was passed through a number of tubes drawn out at both ends, and containing a few grammes of dry iodine till completely saturated, and the tubes then sealed up till required.

A very slow current of Cl_2O (prepared by passing dry chlorine over mercuric oxide previously heated for an hour or more to 250°, in a tube rather more than a foot long, kept cool by water) was then passed through two or three of these tubes connected end to end; from the last tube the excess of gas was conducted into a cylinder containing hydrate of lime.

After a time the ICl_3 became gradually paler in colour, in some places nearly white; but the action is very slow, and even after many hours is only partial, the inner portion escaping the action of the gas.

The excess of ICl_3 was then expelled by placing the tubes in a trough of boiling water and sending a current of dry air through them. Large quantities of vapour of chlorides of iodine then came off, and after a considerable time the contents of the tubes were reduced to a comparatively small quantity of a nearly white, hard, amorphous residue. The last traces of ICl_3 were only got rid of with difficulty.

The residue thus obtained dissolves in water, forming a colourless solution of iodic acid quite free from chlorine if the heating, &c., has been of sufficient duration.

The reaction may be written—

$$2ICl_3 + 5Cl_2O = I_2O_5 + 8Cl_2.$$

We satisfied ourselves by experiment that a considerable evolution of chlorine actually takes place, by passing the gas issuing from the reaction tube through a solution of the brown monochloride of iodine in CCl_4. In a short time a deposit of the orange-coloured ICl_3 was formed, while the Cl_2O before traversing the reaction tube was found to produce no apparent change,—in itself an interesting and rather unexpected fact.

The substance thus obtained was analysed by dissolving a weighed quantity in excess of carbonate of soda, acidifying with nitric acid, and precipitation with nitrate of silver, and weighing the total iodate of silver with the filter dried at 100°. The bulk of it was then detached from the filter and weighed in a bulb tube with a long neck, then heated in an air-bath to 180° or so, when a further slight loss of water takes place. Then, after weighing again, heated carefully over a lamp till the evolution of oxygen completely ceased, leaving a residue of fused iodide of silver, and finally weighed. From the loss of oxygen the percentage of I_2O_5 was then calculated.

Two different preparations gave in this way 97·6 and and 97·1 per cent I_2O_5, numbers which may be taken as sufficient to establish the nature of the reaction, considering the difficulty of drying the very large volumes of gas and air passed over the product.

Our best thanks are due to Mr. F. A. Manning for the use of his Laboratory.

THE LAW OF VOLUMES IN CHEMISTRY.

By T. STERRY HUNT.

The questions regarding the so-called molecular weights and volumes of liquids and solids, which are now attracting the attention of chemists, can, I think, be better understood if we keep in mind the principles enunciated by the writer in 1853, that "the doctrine of chemical equivalents is that of the equivalency of volumes," and that "the simple relations of volumes which Gay-Lussac pointed out in the chemical changes of gases apply to all liquid and solid species;" so that "the application of the atomic hypothesis to explain the law of definite proportions becomes wholly unnecessary." In further illustration of this view, it was said in 1867 that "the gas or vapour of a volatile body constitutes a species distinct from the same body in a liquid or solid state; and the liquid and solid species themselves often [probably always] constitute two distinct species of different equivalent weights." From this it follows that freezing, melting, and vaporisation are chemical changes. The union of many volumes of a vapour or gas in a single volume of a liquid or a solid is a process of chemical combination, while vaporisation is chemical decomposition. Such decomposition is either with or without specific difference, and examples of these two modes are seen respectively in heterogeneous dissociation and in integral volatilisation, which latter is the breaking-up or dissociation of a polymeric species into simpler forms having the same centesimal composition. Both of these processes are subordinated to the same laws of pressure and temperature, and involve similar thermic changes in the relations of the bodies concerned. In this enlarged conception of the chemical process we find a solution of the problems above named, and an explanation of the distinction which has been made between "the chemical molecule" and "the molecule of the physicist." That the latter has a much less simpler constitution than the former, as calculated from the results of chemical analysis and from vapour density, has been long maintained alike on dynamical and chemical grounds. It is discussed by the writer in 1853 in the Essay already quoted, entitled "The Theory of Chemical Changes and Equivalent Volumes,"* and again in the late paper of Spencer Pickering in the Chemical News, November, 1885.

If, then, as maintained by the writer, the law of volumes is universal, and if the production of liquids and solids by the condensation of vapours is a process of chemical union giving rise to polymers, the equivalent weights of which are as much more elevated as their densities are greater than those of the vapours which combine to form them, the hypothesis of atoms and molecules, as applied to explain the law of definite proportions and the chemical process, is not only unnecessary, but misleading. According to this hypothesis, which supposes molecules to be built up of atoms, and masses of molecules, the different ratios in unlike species between the combining weight of the chemical unit or molecule (as deduced from analysis and from vapour density; H = 1·0) and the specific gravity of the mass are supposed to represent the relative dimensions of the molecule. Hence the values got by dividing these combining weights by the specific gravity have been called "molecular volumes." The number of such molecules required to build up a physical molecule of constant volume would, according to this hypothesis, be inversely as their size. If, however, as all the phenomena of chemistry show, the formation of higher and more complex species is by condensation, or, in other words, by identification of volume, and not by juxtaposition, it follows that the so-called molecular volumes are really the numbers representing the relative amount of contraction of the respective substances in passing from the gaseous to the liquid or solid state, and are the reciprocals of the coefficient of condensation of the assumed chemical units. If steam at 100° C. and 760 m.m. pressure, with a formula, as deduced from its density, of H_2O, and a combining weight of 18, is converted into water at the same temperature, 1628 volumes of it are condensed into a single volume, having a specific gravity of 0·9588, which at 4° C. becomes 1·0000. Water is thus $1628(H_2O)$; and the weight of its volume at the temperature of formation, as compared with an equal volume of hydrogen gas or of steam,—in other words, its equivalent weight,—is $1628 \times 18 = 29{,}304$, which thus corresponds to a specific gravity of 1·0000; ice, at its temperature of formation, with a specific gravity of 0·9167, being $1487(H_2O)$, with an equivalent weight of 26,766. The hydrocarbon, $C_4H_{10} = 58$, condenses to a liquid having—according to Pelouze and Cahours—a specific gravity of 0·600, which corresponds to an equivalent weight, as compared with that of water, of 17,582, or approximately $303(C_4H_{10})$, with a calculated specific gravity of 0·5997. The reciprocal of the coefficient of condensation (or so-called molecular volume) of steam is 18, while that of the gaseous hydrocarbon is—

$$600 : 1000 :: 58 : x = 96{\cdot}66.$$

The chemical unit for bodies which, like these, volatilise integrally, is fixed by the density of their vapours; while for fixed species, like anhydrous oxides and silicates, or for those which by heat undergo heterogeneous dissociation, as, for example, calcite and hydrous silicates, the unit may be the simplest formula deduced from analysis, or, for greater convenience in calculation in the case of oxides and silicates, may have a value corresponding to H = 1, or O = 8. The unit for silica thus becomes $SiO_2 + 4 = 15$; that for alumina, $Al_2O_3 + 6 = 17$; and that for the magnesian silicate, $SiMg_2O_4 + 8 = 17{\cdot}5$. Such unit weights as these have been employed by the writer in his late Essay on "A Natural System in Mineralogy," in the tables of which they are represented by P; while the values got by dividing these numbers by the specific gravity of the species have been designated "unit volumes," and represented by V. The writer of that Essay, in de-

* See the author's "Chemical and Geological Essays," pp. 426 to 437, and further, *ibid.*, pp. 453 to 458.

ference to the general usage of chemists, therein adopted the received terminology of "molecular weights" and "molecular volumes," and, failing at the time to grasp the full significance of his own earlier teachings as to the universality of the law of volumes, spoke of the so-called molecular weight as an unknown quantity, although in accordance with that principle this molecular weight, or, properly speaking, this equivalent weight, is simply deduced for any body the specific gravity of which is known.

Centre Harbour, N.H., Sept. 3, 1886.

COUNTER-EXPLANATION AND COMMUNICATION OF FURTHER EXPERIMENTS ON THE CERIFEROUS HAINSTADT CLAYS.*

By Dr. JONAS RUDOLPH STROHECKER.

SINCE criticism has taken the author's analytical results as its object, and as the continuation of his investigation of the precious Hainstadt material has led to important and novel results, he ventures upon a criticism of the present point of view in the chemistry of the rare earths. The criticism of other chemists on his analyses and his own observations on the Hainstadt cerium in its various stages of oxidation (CeO, Ce_3O_4, and Ce_2O_3, the atomic weight being taken as 92·1) come here into consideration; the remaining rare earths, on account of their unequivocal behaviour, require no reformatory communication.

A. Schertel, of Berlin, and Prof. Blomstrand, of Lund, have come forward to criticise the author's analyses. The former judges without practical experience, and admits on p. 1368 of the *Berichte* (1886) that he has not found the rare earths. The Hainstadt clays are very numerous, and Herr Schertel may have obtained specimens free from cerium. Prof. Blomstrand, the most experienced of the Scandinavian mineral chemists, seems to have been in the same case. The critics, however, have come too late, for before their papers could be read considerable quantities of chemical preparations from the Hainstadt cerium clays have been sent into the wide world for experimental purposes, especially lanthanum and yttrium salts. No practical use has hitherto been made of the didymium which occurs only sporadically in the clay bed II. Cerium preparations from cerite have hitherto been preferred to those from the Hainstadt clays, since in the latter cerium occurs in the state of $Ce_2(OH)_6$, which is less readily separated from iron, whilst in cerite it occurs as CeO, which is very easily freed from this impurity. This hindrance is now removed.

Cerium is contained in the clay beds I. and II. as hydroxide, as appears from the following facts:—The non-bituminous flesh-coloured clay No. I. yields at a red-heat bricks coloured orange-red by anhydrous Ce_2O_3 very distinct in their colour from bricks coloured by ferric oxide, and it is thus well-characterised by its own colouration. In its hydrochloric extract, as in that of the unignited black clay II.*a* ammonia yields a reddish brown precipitate which at first sight may be mistaken for ferric hydroxide. But if the clay II.*a* is ignited so that its carbon reduces Ce_2O_3 to Ce_3O_4, the ammoniacal precipitate is of a lemon-yellow ceroso-ceric hydroxide, a fact which has escaped the critics. In the exsiccator the water of hydration remains in both the cerite clays but escapes on heating, leaving orange-red Ce_2O_3, which, in the clay II.*a*, is reduced to the light yellow Ce_3O_4, which becomes brilliantly incandescent, another fact overlooked by the critics.

The solubility of the Hainstadt cerium hydroxide in caustic alkalies is easily demonstrated if the non-bituminous clay No. I. is added in fine powder to a saturated boiling potash or soda-lye and strongly boiled for two days in a covered iron pot, or by putting Ce_2Cl_6 in a strong boiling lye, or by decomposing cerium-alum by a *colourless* caustic lye in the cold. In all three cases the reaction of Ce_2O_3 is to be recognised in the liquid. We come now to the question of the great similarity of the ammonia precipitate from the hydrochloric extract of both the ceriferous clays and from ferric salts. This is due to the circumstance, already put on record in the literature of cerium, that its oxides change their colours strikingly in presence of small quantities of impurities. As the red-brown colour of dry ferric hydroxide may also be called flesh-colour, and actually is (!), it is intelligible how traces of ferric oxide, mixed with $Ce_2(OH)_6$, may give the latter the dark colour of an ordinary ferric precipitate. The iron in a cerium solution completely masks its ferro-cyanogen reaction, and in heat the pale yellow ferrocyanic precipitate of Ce_2O_3 becomes blue on regular acidulation.

To separate perfectly Ce_2O_3 from Fe_2O_3 is practicable only by converting the former into cerium sal-ammoniac, which leaves behind all the iron. It can be readily separated as sulphate, but retains iron, which is simultaneously carried down. The same result occurs in attempts at separation with potassium sulphate, and with oxalic acid it is not precipitated at all.

If it is desired to separate cerium from iron by means of oxalic acid it must be present as CeO or Ce_3O_4, or be reduced to these states. Carbon and caustic potash must be used. The addition of carbon is not necessary in the clay II.*a*. If $Ce_2(OH)_6$ from either clay, still retaining its iron, is fused with caustic potash, it is converted with escape of oxygen into yellow $Ce_3(OH)_8$, which, if heated in contact with the air while still moist, is instantly turned to a leather-brown colour. In this state the oxide evolves chlorine with hydrochloric acid, in proof that Ce_3O_4 is still present along with Ce_2O_3. As ferriferous $Ce_2(OH)_6$ is also reduced by heating with soda, this process may be used to separate it from iron. The mass, when cold, is dissolved in hydrochloric acid, and the filtrate, while still hot, is precipitated with potassium oxalate. The cerous oxalate thus obtained passes, by gentle ignition, into lemon-yellow anhydrous Ce_3O_4, and this again, on further heating, into the orange-red anhydrous Ce_2O_3, the cheap preparation of which, as a painters' colour, is now in prospect. At a white heat the colour changes to a leather-brown. The cause of this colour appearing in bricks is not so much the presence of iron as that of an unreduced portion of Ce_2O_3. It cannot be assumed that the presence of lanthanum has an effect on the colour of the bricks.

A further point is the blue melt which caustic potash produces with the clay I., and with the ferriferous $Ce_2(OH)_6$, obtained from both clays. According to previous traditions it must have been regarded as a solution of CeO in potash, since CeO is the only blue stage of oxidation. But this view could not be verified. As manganese occurs only here and there in very slight traces in the Hainstadt clays, and as the colour of the melt is different from that of this metal, it may remind us of CeO_3, ceric acid. But there was a difficulty in admitting a ceric acid; on attempting to obtain pure $Ce_2(OH)_6$ from the ferriferous product by extraction with hot ammonium carbonate there was obtained the above-mentioned flesh-coloured preparation. But this, if fused with alkali, gave not a blue but a light flesh-coloured melt, so that the element which is the basis of the blue compound cannot be the cerium extract.

What element is here present is not known to the author. The like must be said of the sky-blue matter separated on adding potassium hydroxide to the solution of a cerium salt, as well as of the steel-blue colour of the ignited mass. As the unknown element was contained in the cerite oxides as precipitated by potassium sulphate we have here a *proserpinium* if the metal approximates to

* Reprint from *Technische Mittheilungen für Malerei*, courteously forwarded by the Author.

cerium, or a *quirinium* if the metal found in the Hainstadt clays approaches iron. It is also possible that cerium, like didymium, may be resolved into two metals. A further observation refers both to cerium and iron. In preparing the flesh-coloured compound, $Ce_2(OH)_6$, by means of ammonium carbonate it appears that the reddish brown liquid floating above the precipitate, and containing cerium and iron in molecular distribution, reddens blue litmus, thus rendering intelligible the solubility of the Hainstadt $Ce_2(OH)_6$ in caustic alkali.

ON THE MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from p. 197.)

In the study of the nature of minerals, according to optical methods, we can make use of prepared specimens as soon as they have had any adhering Canada balsam cleaned off, and these specimens can be preserved for an indefinite time. All modifications in the methods of examination naturally arise from changes effected in the apparatus employed; if we assume that this fulfils certain necessary conditions the specimen has to undergo no other manipulation beyond being removed from the object stage of the microscope. Further, if we consider that microscopic examination, as it has been developed by the work of Sorby, Zirkel, and Vogelsang, enables us to arrive, in the space of a few minutes, at a definite solution of several questions which could not be answered by a mere inspection of the sample, and that microscopic specimens of rocks prepared in thin plates are equally as good as animal or vegetable specimens both in sharpness of detail and beauty of colouring, we can easily understand why naturalists have a leaning towards optical methods of examination. The study of minerals by these means is a most convenient one, when carried out by the aid of excellent apparatus, and it enables us to submit the matter in question to most searching enquiry, and to determine its nature without injuring the specimen, and, in addition, this method takes but little time and is easy to carry out.

The determination of minerals according to their form and their physical properties, brought to perfection by the work of Werner and Mohs, even to forming a complete system, was obliged to give way to a method of research based on the application of chemical reactions. However, in modern micro-mineralogy, these older methods have again acquired a preponderating value, having some particular properties which result from the conditions under which thin plates of minerals, cut in any direction, may be studied.

Among the minerals which may be sliced in this manner is very rare that substances entirely opaque are found; but among those which are, magnetic iron ore, titaniferous iron, and pyrites may be mentioned.

The influence of the inequality of planes and the opacity of matter, which so often interfere with the use of the goniometer, and of M. Kobell's stauroscope, is diminished or entirely removed by the use of extremely thin plates, and as to the direction of cleavage, which is generally found by using a hammer and chisel, it is nearly always indicated by parallel cracks.

Interposed matter has only attracted the attention of mineralogists after the use of the microscope became general. These allied matters are so characteristic of some minerals that their presence helps the recognition of certain species, such as haüynite, nosite, leucite, quartz, garnet, &c.

In cases where optical means cannot be employed the microscopist is at a disadvantage compared with those who employ the older methods; for how can he determine the hardness or density of minerals judge accurately of their lustre and colour, or recognise their crystalline character, and their behaviour with chemical reagents? In face of these objections every effort has been made to increase the delicacy and accuracy of optical methods of examination.

Anyone who would have an idea of the results obtained by the means described, when employed by experienced and skilful observers, need only look through the records of petrography for the last fifteen years; as a matter of fact these results have brought about a complete revolution in the science. On the other hand, anyone who has been occupied in the microscopic examination of minerals in thin plates, will be well aware, by his own experience, how much care and experience are required in order to achieve results worthy of confidence, and in how many cases, in spite of the most scrupulous care, there still remain doubts and uncertainties, especially when one is dealing with an old or much abraded specimen.

The use of apparatus for polarisation in the determination of the system of crystallisation, is only practicable in cases when the direction of cleavage, or the well-defined character of the crystal, renders the rotation of the principal axis possible. Sometimes it takes a considerable time to ascertain this, and in the case of amorphous matters or crystals of the regular system the above named method is entirely inapplicable. In fact, in the latter case one is obliged to depend on the differences of structure, transparency, and colour, and in more favourable cases on the character of the accompanying matter. As an example of these undecipherable bodies I may mention the fundamental matter of the different porphyry rocks, and the efflorescent products of felspar and augite, which have been named saussurite and viridite; and again, those opaque bodies, indefinite with regard to their crystalline form, which have been named *opacite* when of a black colour and *ferrite* when the colour tends towards brown; two names which have no advantage except in enabling us to say in one word that we do not know the true nature of the objects referred to.

(To be continued.)

ON CALCIUM BORATE.

By BERTRAM BLOUNT.

The constant formation of definite vitreous balls, when caustic lime is taken up on a boric oxide bead before the blowpipe, which float insoluble in the surrounding medium, observed by Rose, led me to endeavour to prepare the body on a scale which would admit of subsequent analysis.

Accordingly freshly calcined lime was added to recently fused boric oxide in a platinum crucible, and the mixture heated over a Bunsen burner till the lime sank in and adhered to the boric oxide, so that none could be blown out when further heated in a Fletcher's gas-furnace.

In this apparatus perfect fusion was maintained for ten or fifteen minutes, the crubible removed while hot, and allowed to cool on an anvil, so as to thoroughly crack its contents.

While in a state of fusion the borate could be seen as a spheroid immersed in the pool of boric oxide, but when taken out cold it formed a layer, having its upper surface slightly concave, at the bottom of the crucible, and had no spheroidal shape.

The borate thus obtained was a hard glassy body, which cracked on cooling after fusion,—though less readily than boric oxide,—permanent in air, but slowly, though completely, decomposed by digestion with water.

Its composition was ascertained—

(i.) By synthesis.

(ii.) By analysis.

(i.) A weighed portion of lime, containing only small quantities of water and carbon dioxide as impurities, was

heated in a gas muffle till its weight was constant; boric oxide was then added, and the fusion conducted in the manner described above.

(In some cases pure dry calcium carbonate was used to start with: in this case it was first heated to expel the greater part of the CO_2, to prevent frothing, and then treated with boric oxide.)

The crucible with its contents was then digested with warm methylated alcohol, and the insoluble borate received on a weighed filter-paper, washed with alcohol till free from boric acid, dried, and weighed. Alcohol, even when somewhat dilute, seemed not to affect the borate like water.

The numbers for one such operation are—

	Grms.
Weight of calcium carbonate taken ..	= 1·2317
Weight of calcium borate obtained ..	= 2·4546
∴ Percentage of calcium oxide in the borate	= 28·10 %.

(ii.) A weighed portion of the borate thus formed was dissolved in warm hydrochloric acid, diluted with an equal bulk of water, ammonia in excess added,—which brought down a white flocculent precipitate, probably some other calcium borate, acetic acid in excess added to re-dissolve this precipitate, and finally the lime thrown down by ammonium oxalate.

The calcium oxalate thus formed was either received on a weighed filter, or, if the weight of the filter was not known, it was removed from it and weighed separately, the filter being ignited over the blowpipe, and the particles adhering to it calculated as caustic lime.

This latter method is to be recommended for quickness without sacrifice of accuracy.

The weight thus obtained was confirmed by afterwards weighing the precipitate as any or all of calcium carbonate, oxide, or sulphate.

The numbers for such an analysis are appended:—

	Grms.
Weight of calcium borate taken.. ..	= 1·45
Weight of calcium oxalate obtained ..	= 1·0501
Weight of calcium oxide + filter ash ..	= 0·0106
Weight of ash..	= 0·0003
∴ Weight of calcium oxide	= 0·0103
∴ Percentage of calcium oxide in the borate	= 28·49 %.

These numbers correspond more nearly to the composition of the calcium analogue of borax than any other compound.

Percentage of CaO in CaB_4O_7:—

Calculated.	Found.
—	28·1 (synthesis)
28·57	28·49 (analysis).

This body is sufficiently well known, though the only mention I find of it is that it is obtained in the crystalline form by the fusion of various calcium borates, made by wet methods, with excess of boric acid in presence of a mixture of alkaline chlorides as a medium. (I observed the formation of such a substance when lime and excess of boric oxide are fused for some time in presence of alkaline chlorides, but did not analyse it.)

The salt is also found native, crystalline and hydrated, in Peru.

There were indications of the possibility of the formation of borates containing a higher proportion of boric oxide, if it were present in very large excess and the temperature were high.

This is quite compatible with the known tendency of boric oxide to combine with varying proportions of bases according to external conditions; as an instance one may note the expulsion by boric oxide, from excess of barium carbonate, of 2 or 2½ molecules of carbon dioxide, according to the temperature employed (Bloxam). Accordingly it is possible that the body obtained on a platinum-wire ring before the blowpipe, where the excess of boric oxide is very large and the temperature extremely high, may contain a larger proportion of boric oxide than that formed in a crucible in a gas-furnace; the preparation of a large number of globules before the blowpipe, and their analysis, is necessary for the confirmation or disproof of this supposition.

Chemical Laboratory, King's College,
September 20, 1886.

THE ACTION OF REAGENTS ON COBRA-POISON.

By C. J. H. WARDEN, Surgeon, H.M.'s Bengal Staff,
Professor of Chemistry, Calcutta Medical College.

(Concluded from p. 199.)

In the experiments already quoted, it will have been observed that the duration of life after injection of the poison is inversely proportional to the dose administered. In the two experiments in which 0·00002 grm. was injected the mice lived for 1 h. 50 m. and 1 h. 17 m. respectively. With a dose between 0·00001 and 0·00002 grm. death did not ensue until over three hours after the injection. The maximum duration of life, therefore, after the administration of the minimum fatal dose, appears to be a period varying between three and four hours. Dealing with larger doses, it would appear that amounts varying betweeen 0·0001 and 0·0004 of a gramme prove fatal in from 33 to 36 minutes. In order to ascertain the minimum duration of life after the injection of an overwhelmingly large dose, the following experiment was performed:—

Exp. 4.—0·02 grm. of dry but not anhydrous venom was dissolved in 0·5 of a cubic centimetre of distilled water. A full-grown mouse was injected at 11.13 a.m. with 0·3 c.c. of the solution; breathing ceased at 11.17 a.m. Ratio of poison to body weight, 1 to 1247. The animal was powerfully convulsed. A dose, therefore, of 0·012 grm. was fatal in four minutes.

Regarding the ratio of the minimum fatal dose to the body weight, it would appear that a ratio of 1 to 7,900,000 is fatal, but this is evidently not the extreme limit, as it represents the action of two-hundredths of a milligramme of dry but not anhydrous venom, while, as has been previously stated, there is reason to believe that the minimum fatal dose is more than one-hundredth, and less than two-hundredths, of a milligramme, equivalent to 0·000008 and 0·000016 of a gramme of the anhydrous poison. It may therefore be stated approximately that the maximum fatal ratio is probably one to ten or eleven millions. It need scarcely be pointed out that the fatal ratio of poison to body weight deduced from these experiments probably holds good only in the case of healthy full-grown white mice; and to draw any conclusions from these data as to the fatal dose to body weight in the case of other animals, would in all likelihood be fallacious.

The Action of Heat.—Wall was the first, I believe, who investigated with any precision the effect of heat on cobra-venom, and, as his results are of considerable interest, I thought it necessary to perform experiments on this point. But the effects of heat on cobra-poison possess additional interest, on account of the marked analogy which exists in the action of this physical agent on a poison of vegetable origin—*Abrus precatorius*—and which has been pointed out also bears a marked physiological analogy to snake-poison.

Exp. 5.—A solution of dry, but not anhydrous, cobra-poison, containing 0·0001 grm. per cubic centimetre of distilled water, was heated in a sealed flask in a water-oven for four hours. The highest temperature registered in the oven being 93° C. After heating, as the solution

was somewhat milky, it was filtered, and with the clear filtrate four mice were injected.

(*a*) With 0·2 c.c. Not fatal.
(*b*) With 0·2 c.c. Not fatal.
(*c*) With 0·4 c.c. Not fatal.
(*d*) With 0·4 c.c. Not fatal.

In this experiment, thus twice the minimum fatal dose failed to kill.

Exp. 6.—A solution of dry cobra-poison was made, by dissolving 0·05 grm. in 50 c.c. of distilled water, and placed in a flask provided with a well-fitting cork carrying a thermometer, and the flask immersed in water, which was then gradually heated till the thermometer in the flask indicated 50° C., and this degree of heat was steadily maintained for three hours and twenty minutes. A portion of the liquid was then removed, and diluted in the proportion of 2 c.c. to 8 c.c. with distilled water. One mouse was injected with 0·1 c.c., equal to 0·00002 grm. of dry venom. Death ensued in one hour and twelve minutes.

Exp. 7.—The remainder of the undiluted solutions used in the last experiment was again heated to 65° C. for three hours and thirty-five minutes. A portion was then filtered and diluted with distilled water in the proportion of 2 to 8. With this diluted solution two mice were injected.

(*a*) With 0·1 c.c., equal to 0·00002 grm. Fatal in 3 hours 22 minutes.

(*b*) With 0·3 c.c., equal to 0·00006 grm. Fatal in 45 minutes.

Exp. 8.—The remainder of the undiluted solution from the last experiment was again heated to 75°—79° C. for three hours and fifteen minutes. As the solution was only faintly opalescent it was not filtered. A portion was diluted to the same strength as employed in the last two experiments. Two mice injected.

(*a*) With 0·1 c.c., equal to 0·00002 grm. Not fatal.

(*b*) With 0·3 c.c., equal to 0·00006 grm. Death in 55 minutes.

Exp. 9.—The remainder of the undiluted solution from the last experiment was once more heated to 85° C. for four hours and fifteen minutes. The solution was now highly opalescent, and filtration through several folds of filter-paper failed to render it bright; a portion was therefore strongly agitated with a few small fragments of well-washed filter paper, and, by returning the filtrate two or three times, a bright transparent liquid was ultimately obtained. Two sets of experiments were now made, one with the unfiltered and turbid solution, and the second with the filtered and transparent.

Exp. A.—With unfiltered solution. Two cubic-centimetres diluted with 8 c.c. of distilled water. One mouse injected with 0·3 c.c., equal to 0·00006 grm. Not fatal.

Exp. B.—With clear filtered solution. Two cubic-centimetres diluted with 8 c.c. of distilled water. One mouse injected with 0·3 c.c., equal to 0·00006 grm. Not fatal.

Exp. C.—One mouse was injected with 0·2 c.c. of the unfiltered and undiluted solution equal to 0·0002 grm. Not fatal.

The results obtained by the foregoing experiments may be tabulated as follows:—

An aqueous solution of cobra-venom containing 0·001 grm. per cubic centimetre of dry but not anhydrous poison, when

Heated to 50° C. for 3 h. 20 m.—0·00002 grm. of the venom was fatal in 1 h. 12 m.

Heated to 60° C. for 3 h. 35 m.—0·00002 grm. of the venom was fatal in 3 h. 35 m. (0·00006 grm. in 45 m.)

Heated to 75°—79° C. for 3 h. 15 m.—0·00002 grm. Not fatal.

Heated to 75°—79° C. for 3 h. 15 m.—0·00006 grm. Fatal in 55 m.

Heated to 85° C. for 4 h. 15 m.—0·00006 grm. Not fatal.

Heated to 85° C. for 4 h. 15 m.—0·0002 grm. Not fatal.

The temperature at which a diminution in the toxic power of the venom is first strikingly apparent is between 79° and 85° C., and this range of temperature corresponds with the degree of heat at which a considerable precipitate occurs when an aqueous solution of the venom is heated. Experiment 5 indicated that after exposing a solution to 93° C. for four hours, that twice the ordinary fatal dose was inactive; in the subsequent experiments after 14 h. 25 m., non-continuous exposure of the same solution to temperatures varying between 50° and 85° C., ten times the minimum fatal dose failed to kill. The question here arose, is *time* a factor? In other words, in order to lessen the activity of the poison, is it merely necessary to heat a solution to a temperature of 85° C. for a few moments, or must that degree of heat be maintained for some time; and will exposure to a high temperature for a short period be equivalent to prolonged heating at a lower temperature? Again, as has already been pointed out, at 79°—85° C. there is a marked coagulation of albuminous matter; is the action of heat on this principle merely a physical one, or does it modify in any manner the toxic power of the venom considered as a whole? If the diminution in activity of the venom by heat be solely dependent on coagulation, then reagents which coagulate proteids ought to have a similar effect in lessening the activity of the poison. On the other hand, we have Mitchell's experiments, which indicate apparently the complex nature of the venom; it is therefore possible that the mere act of coagulation by heat, or by a reagent, may modify the toxic power of one constituent, without lessening in any marked degree the toxic power of the venom when considered as a whole. As bearing on these several points the following experiments were performed:—

Exp. 10.—An aqueous solution of cobra-poison containing 0·002 grm. of dry venom per cubic centimetre, was heated to 85° C. for five minutes. As only a small amount of solution was employed, the requisite temperature was reached in less than two minutes. An abundant precipitate was produced; the solution was allowed to cool, and a mouse injected with 0·2 c.c. of the unfiltered solution, equal to 0·0002 grm. of venom. Death ensued in 31 minutes.

Exp. 11.—To a solution of cobra-poison of the same strength as that employed in the last experiment, a small amount of solid picric acid was added, the liquid well agitated, and with the turbid solution one mouse injected with 0·2 c.c., equal to 0·0002 grm. Death ensued in 31 minutes.

Exp. 12.—As a control experiment a mouse was injected with the same amount of venom solution employed in the last two experiments, but without the addition of picric acid. Death ensued in 23 minutes.

Experiments 10 and 11 were performed at the same time, so that one control experiment sufficed. In these three last-quoted experiments the symptoms noted are worthy of record. In the case of the mouse injected with the solution which had been previously heated, after the injection it remained in one place in a crouching posture; the breathing at first was hurried, then became slower; the animal never moved, it seemed petrified; and it died in the same posture which it first assumed, without any convulsive movements whatever. In the case of the mouse injected with the solution containing picric acid, marked convulsive movements ensued prior to death. Without a control experiment it might be argued that Mitchell's "venom-peptone"—a convulsive agent—had been destroyed by the action of heat. The control mouse, however, which had received the same amount of poison, without having been previously heated, exhibited precisely similar symptoms; it never moved after the injection; it died in a crouching posture, and there was a total absence of convulsive movements.

It is interesting to note how the symptoms vary with

the dose of poison administered; thus with overwhelmingly large doses powerful convulsive movements ensue; doses approaching the minimum fatal limit also cause convulsions, but with a dose approximating to two-tenths of a milligramme of dry but not anhydrous poison, there is a total absence of all convulsive movements. These experiments indicate the caution with which inferences should be drawn of a change in chemical composition, when based merely on differences of physiological action.

Exp. 13.—A solution of cobra-poison containing 0·001 grm. per cubic centimetre of dry but not anhydrous venom was heated to 85° C. for five minutes, rapidly cooled and filtered. The clear filtrate gave a slight precipitate with picric acid, another portion on further heating became slightly opalescent. One mouse was injected with 0·1 c.c., equal to 0·0001 grm. Died in 35 minutes with marked convulsions.

Exp. 14.—A fresh solution of the same strength as used in the last experiment was heated in a water-bath to 85° C., which occupied six minutes, and the solution was kept at that temperature for five minutes, and then rapidly cooled. One mouse was injected with 0·2 c.c. of the unfiltered solution, equal to 0·0002 grm. of dry but not anhydrous venom. Death ensued in twenty minutes; no convulsive movements.

Exp. 15.—The solution used in the last experiment was again heated to 85° C., which occupied four minutes, and then kept at that temperature for ten minutes. Total heating below a temperature of 85° C. ten minutes, and at 85° C. fifteen minutes. After heating the solution was rapidly cooled, and a portion filtered; 0·2 c.c. of the filtrate injected into a mouse caus d death in thirty minutes, with a total absence of all convulsive movements.

Exp. 16.—The remainder of the unfiltered solution from the last experiment was again heated to 85° C., which occupied six minutes, and then kept at that temperature for fifteen minutes and rapidly cooled. Total heating below 85° C. sixteen minutes, at 85° C. thirty minutes. One mouse injected with 0·2 c.c. of the unfiltered solution. Death in thirty-nine minutes; no convulsive movements.

Exp. 17.—A fresh solution was prepared, containing 0·001 grm. of dry venom per cubic centimetre of distilled water; and the solution heated continuously to 85° C. for forty minutes and allowed to cool slowly. One mouse injected with 0·2 cubic centimetre of the unfiltered solution, equal to 0 0002 grm. of venom. Death in thirty-six minutes.

Exp. 18.—A fresh solution of venom was prepared, of the same strength as that used in the last experiment, and rapidly boiled for two minutes. One mouse injected with 0·1 c.c., equal to 0·0001 grm. Death in thirty-five minutes.

Exp. 19.—Solid picric acid was added to a solution of venom containing 0·001 grm. per cubic centimetre, the solution well agitated and immediately filtered. The filtrate was yellowish, from excess of picric acid, but perfectly bright. On heating a small portion no cloudiness ensued. One mouse was injected with 0·2 c.c. of the unheated filtrate; the animal was decidedly affected, but death did not ensue. The remainder of solution was kept, and after standing for 62 hours at 15° C., yielded a considerable white precipitate. and to the presence of this coagulable matter the symptoms which followed the injection were probably due.

The experiments which have been described would appear to indicate that the mere act of coagulation by heat at 85° C., or at 100° C. of certain principles contained in an aqueous solution of cobra-poison does not lessen in any marked degree the toxic power of the venom. Similar remarks would also appear to apply to a reagent such as picric acid, which causes an abundant precipitate in solutions of the poison. With heat as the coagulating agent, coagulation is probably the first visible step in the chemical change in constitution of one or more of the proteids which go to make up the venom. For heat to lessen the toxic power of cobra-poison, time is a most important factor; short exposure to a high temperature not being equivalent to the prolonged action of a lower degree of heat.

The Action of Picric Acid.—A solution of cobra-venom containing 0·0002 grm. per cubic centimetre of distilled water was mixed with an excess of solid picric acid, the mixture was agitated and immediately filtered. One mouse was injected with 0·1 c.c., equal to 0·00002 grm. of dry but not anhydrous venom. Not fatal, though the symptoms produced were marked.

As a control experiment one mouse was injected with the same amount of cobra-venom solution, without the addition of picric acid. Death ensued in twenty-seven minutes, being immediately preceded by violent convulsions.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING SEPTEMBER 30TH, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, October 7th, 1886.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 182 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

Altogether the character of the London water supply has continued to be excellent throughout the past month. The mean proportion of organic carbon in the Thames-derived supply was 0·133 part, with a maximum in any one sample of 0·151 part in 100,000 parts of the water, as against a mean of 0·141 part, and a maximum of 0·177 part in the preceding three months' supply.

The succeeding paragraphs set forth the general results of a third series of bacteriological experiments, made in continuation of those described in our two previous monthly reports. In these experiments Thames-derived ordinary town-supply water was sterilised during the passage through it of a current of sterilised carbonic acid, so as to retain the earthy carbonates in solution. After sterilisation it was allowed to become re-aërated by standing for forty-eight hours in cotton-plugged flasks before being subjected to experiment. In each experiment, by means of sterilised pipette-bulbs as nearly as might be of equal capacity, a quantity of peptone-fluid, loaded with an active sporeless growth of *bacillus anthracis*, was added to the sterilised water in the proportion, roughly, of 1-600th or 1-700th of its bulk; though it is possible

that this proportion may, now and then, have been more or less departed from. To contaminate to the same extent the entire daily flow of Thames water from which the daily London supply is withdrawn, would require an addition thereto of over a million gallons of bacillus-charged animal fluid; while to contaminate to the same extent a day's supply of the Thames water actually withdrawn would require an addition thereto of at least a hundred thousand gallons of the same animal fluid. The experiments were made mostly on different days from May 4 to May 19, inclusive. In twelve duplicate experiments the infected water was kept at the temperature of the room, which ranged from 58° to 63° F. (14·5 to 17·5° C.); while in four single experiments it was maintained artificially at the temperature of 90° F. (32° C.). After intervals of half an hour, and again after intervals of six hours, tubes of sterilised culture fluid were sown with the infected water, and subjected to incubation for eighteen hours and longer at 90° F. (32° C.). The general result of this series of experiments is as follows:—

The tubes of culture-fluid, sown with the infected water within half an hour of its having been infected, were found invariably to exhibit, after eighteen hours incubation, a characteristic growth of bacillus. As regards the sowings made with the same infected water that had afterwards been kept for six hours at the temperature of the room, in one of the twenty-four tubes of culture-fluid, corresponding to the twelve duplicate experiments, there was some growth of bacillus observable after its incubation for eighteen hours; but subsequent sowings with this particular specimen of infected water, made the next morning, proved wholly infertile on incubation, though kept up for a period of three days. In the other twenty-three tubes of culture fluid, sown with water that had been infected six hours previously and kept at the temperature of the room, there was no development whatever of bacillus after an incubation extending in each experiment to three, and in some instances to four days. Similarly, with regard to the four experiments in which the culture fluid was sown with water that had been infected for six hours, during which it was maintained at the temperature of 90° F., in no instance did the sowings prove fertile on even prolonged incubation.

Subsequent series of experiments were undertaken with a view to ascertain whether the duration of the period of infectivity in purposely infected river water in its ordinary state differed at all from that observed in the case of the sterilised river water; and also to ascertain the influence of a greater or less proportion of added nutrient animal fluid in prolonging or diminishing the duration of the period of infectivity. Particulars of these series of experiments will be given in future reports.

We are, Sir,
Your obedient Servants,

William Crookes.
William Odling.
C. Meymott Tidy.

CORRESPONDENCE.

CONDENSATION OF GASES BY POROUS BODIES.

To the Editor of the Chemical News.

Sir,—The interesting paper by the Rev. A. Irving, on Dissociation and Contact-Action (Chemical News, vol. liv., p. 179), recals a speculation which occupied my mind a good deal three or four years ago, as to the cause of the condensation of gases by porous bodies: the two subjects, though not identical, are closely related, and an adequate explanation of one is likely at least to throw light upon the other.

If we start with a vessel of ordinary proportions containing a gas, and suppose the diameter to be gradually narrowed, we see that an increasing number of molecular shocks must fall upon the rigid walls instead of expending themselves upon neighbouring molecules. In the theory put forward by Mr. Irving the greater violence of this impact against a solid is supposed to be transformed into intra-molecular energy tending to dissociation, but there are further consequences involved into which he does not enter. If the walls of the containing vessel be narrowed until it becomes a pore not greater than the mean free path of the molecule, it would seem as if the motion of the latter would consist to a great extent of a violent rebound from wall to wall, leaving the space behind it comparatively free from pressure, and therefore adapted for the close approach of another molecule in its rear; we should thus expect on *à priori* grounds that any minutely porous body would effect the condensation of gases.

Now it is probable that the clean surface of any metallic plate produced by pressure (such as blows or rolling) is minutely porous, but only those metals called "noble" are able to retain their cleanliness; the atmospheric oxygen enters the pores, is condensed in them, and thus brought into intimate molecular contact with their walls, owing to the violent rebounds required by the theory: this in itself would promote combination, independently of the transformation of energy postulated by Mr. Irving, which probably assists the reaction; and so we get a superficial oxidation and a plugging of the pores with oxide, which prevents further action.

The best illustration of the action of a porous body is condensing a gas is afforded by the familiar lecture experiment of introducing a piece of recently ignited charcoal into a tube containing ammoniacal gas over mercury, when the enormous force with which condensation is effected is shown by the mercury rising to the height of 10 or 12 inches in the tube.

A communication was prepared some time ago on the above subject, but was suppressed, partly because the ideas involved appeared crude and undeveloped, and partly on account of the great difficulty experienced, perhaps for that reason, in giving them clear expression. I am encouraged, however, by the appearance of Mr. Irving's paper to lay my views, which to some extent run parallel with his, before your readers.—I am, &c.,

Thos. Blunt, M.A. Oxon, F.C.S.

The Wyle Cop, Shrewsbury,
October 15, 1886.

FLAME SPECTRA.

To the Editor of the Chemical News.

Sir,—Many of your readers may have found a difficulty, in common with myself, in procuring a continuous spectrum in the usual way, with a bead on platinum wire, in the Bunsen flame. Lately I have used a solution of the salt, injecting it as spray into the flame by means of an ordinary glass spray producer attached to a pair of Fletcher's bellows, with complete success. Others may perhaps be glad to know this, and to improve upon my simple method. And the manufacturers of chemical apparatus may think it worth while to give us a lamp suited for use with the spectroscope on this principle.—I am, &c.,

G. F. M. Fielding.

Hobart, September 1, 1886.

Formation of Sulphuric Acid during the Preparation of Dithionic Acid.—W. Spring and E. Bourgeois. The facts observed demonstrate that SO_3 forms with water a very instable compound, which is oxidised by manganese peroxide to the state of dithionic acid; SO_3 not hydrated, though dissolved, passes into the state of sulphuric acid.—*Bull. de la Soc. Chim. de Paris.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 13, September 27, 1886.

Researches on Sugars.—M. Berthelot.—The author has recently investigated some new principles resulting from the mutual association of the sugars, not in stable combinations like the saccharoses, but compounds easily split up, even by solvents, and similar to the hydrates and alcoholates. He obtained a compound of levulose and glucose, characterised by its rotatory power, found to be $\alpha_D = +32{\cdot}2°$.

No. 14, October 4, 1886.

On Sodium Glycerinate.—M. de Forcrand.—Glycerin is attacked in the cold by the alkaline metals, with formation of a glycerinate and escape of hydrogen. The reaction is soon arrested in consequence of the viscosity of the liquid, the fragments of the metal being coated with a layer of solid glycerinate. If heat is applied the matter turns black and an explosion ensues. In 1872 Letts published a process for preparing sodium glycerinate by precipitating sodium ethylate dissolved in an excess of absolute alcohol by an equivalent quantity of glycerin. It is a very general property of the alkaline glycerinates to unite with a molecule of a mono-atomic alcohol to form crystalline compounds; the author has obtained several of these compounds analogous to the poly-alcoholic ethylates and methylates. From a table here given it appears that the quantities of heat evolved increase progressively; the polyatomic alcohols give compounds more stable than do the monoatomic alcohols, and from this point of view they are intermediate between the latter and the aldehyds or the phenols.

Preparation of Calcium Sulphide having a Violet Phosphorescence.—A. Verneuil.—There exists in commerce a calcium sulphide remarkable for the intensity and duration of its violet phosphorescence. The analysis of this product shows that it is composed of calcium monosulphide about 37 per cent, lime 50 per cent, calcium sulphate 7, and calcium carbonate 5 per cent, with traces of silica, magnesia, phosphates, and alkalies. The presence of tests of siliceous foraminifera shows that the lime employed has been obtained from the shells of a mollusk. On further examination he detected a very small quantity some ten thousandth parts, of bismuth sulphide. The following method for its preparation gave the best results:—20 grms. lime obtained by igniting the shell of *Hypopus vulgaris* to bright redness are finely pulverised and intimately mixed with 6 grms. roll sulphur and 2 grms. starch. To this mixture are added, drop by drop, 8 c.c. of a solution containing ½ grm. bismuth subnitrate, 100 c.c. absolute alcohol, and a few drops of hydrochloric acid. When the chief part of the alcohol has evaporated, which will require about half an hour, it is heated for about 20 minutes to a light cherry red heat in a covered crucible. When completely cold the slender layer of gypsum which has been formed on the surface is removed, the product is pounded and ignited again at the same heat for fifteen minutes. If the heat has not been too strong the product obtained is formed of small grains scarcely agglomerated. A repeated pulverisation diminishes the phosphorescence. Pure calcium sulphide does not phosphoresce for any appreciable length of time. The substances which render the sulphide phosphorescent are those which frit slightly under the influence of heat.

Comparative Volatility of Methylic Compounds in the Various Families of the Negative Elements.—Louis Henry.—For equal atomic weights the decrease of volatility effected in methane by the substitution of a negative element X for hydrogen is so much the greater as this element is more negative, and consequently more remote from hydrogen.

Bulletin de la Société Chimique de Paris.
Vol. xlvi., No. 2, July 20, 1886.

At the Session of the Society, June 25, 1886, M. Maumené mentioned the fact that potash alum dried, not over sulphuric acid but over calcined alum, contains 29 equivalents of water, a fact foreseen by his general theory. M. Maumené also laid before the Society the details of the industrial preparation of vermilion, which he obtains by causing mercury to react upon calcium sulphide. He obtains at pleasure either the black modification by using a dilute solution containing a little ammonium hydrosulphate or the scarlet variety by heating the mixture to about 110°.

Reaction for Distinguishing Coal-Tar Colours from Colouring Matters of Vegetable Origin.—Ch. Blarez and G. Deniges.—The author's researches bear upon the detection of colouring matters in wines. They take 10 c.c. of the wine under examination, add 10 drops of glacial acetic acid, and heat to 100°. They then throw into the hot liquid 0·20 grm. of pulverised mercuric acetate, cool under a jet of cold water, and pour upon a filter. All the natural wines examined have been decolourised or have given a feebly yellowish filtrate. It has proved the same with wines coloured with vegetable dyes. Wines coloured with the majority of coal-tar products give a coloured filtrate.

Contribution to the Study of the Platinum Salts.—Eug. Prost.—At present we generally consider as normal salts those which result from the union of molecules of anhydrides and bases in a simple proportion according to their valency. This view seems scarcely admissible; it implies, in fact, that a molecule of a given anhydride is saturated to the same degree on uniting with a molecule of any oxide whatever, strong or feeble, and conversely, that any molecule of base exhausts its chemical energy by combining with a molecule of the different anhydrides. According to this conception sulphuric anhydride would be equally saturated by a molecule of the oxide of potassium, of zinc, or of lead. In fact the matter is scarcely rational. We may ask if the molecules of oxides which enter into the composition of the so-called basic salts are not there to supply a want of energy in the base as compared with the anhydride? Are not the salts now known as basic rather to be regarded as normal? The author proposes to contribute to the verification of this fact by studying the combinations of platinum oxide, one of the feeblest bases, with the various strong anhydrides. He has accordingly examined platinum nitrate, perchlorate, sulphate, and the double salts of platinum and of the alkaline metals. The facts ascertained show the insufficience of the chemical energy of platinum oxide with regard to the strong anhydrides.

Justus Liebig's Annalen der Chemie,
Vol. ccxxxiv., Parts 1 and 2.

Researches on the Molecular Refraction of Liquid Organic Bodies of Great Power of Dispersing Colours.—J. W. Bruehl.—The dispersion of colours effected by different bodies bears so far no distinct relation either to the refraction of light which they exercise or to the chemical nature of the substances. The constant $(n-1)\frac{P}{d}$, hitherto used as an expression for molecular refraction, is generally applicable only for bodies of the fatty series, but for unsaturated compounds it is serviceable only in cases of feeble dispersion, and even then its results are not always trustworthy. If the dispersion is strong it is quite. For examination of the relation between

luminous refractive power and constitution the above formula is therefore to be rejected and the value—

$$\frac{(n^2+1)}{(n^2+2)}\frac{P}{d}$$

is to be used in its place.

Non-Acid Components of Bees'-Wax.—Fr. Schwalb.

Action of Aluminium Chloride.—R. Anschütz.—The first portion of a very extensive memoir which does not admit of useful abstraction.

Supplementary Remarks on Pseudo-morphine.—O. Hesse.—The author criticises the researches of Polstorff and Donath on this subject, and gives his views on the origin of pseudo-morphine from morphine.

MISCELLANEOUS.

Evening University Lectures at King's College, London.—During the winter, commencing on October 25th, five courses of lectures, having similar scope to those delivered at the Universities, and given with a view to assisting independent study, will be given at King's College. Each course will consist of not fewer than eight lectures, the subjects being, French and German Literature, Classic History and Art, the Geometry of Newton, and Iron and Steel. In the last-named course, which will be delivered on Tuesday evenings from 7 to 8, it is proposed to treat of the general methods by which the different qualities of malleable iron, cast iron, and steel may be produced and prepared for use in the Arts; of the effect of the various foreign substances contained in these metals upon their strength and fitness for the purposes to which they are to be applied; of the extent to which these substances are injurious, and the means by which they are commonly eliminated.

Poisonous Properties of the Hop.—Hopeine, a principle found most abundantly in the wild hops of America, produces effects very similar to those of morphine, but acts more powerfully if introduced subcutaneously. It is found as a white powder, sparingly soluble in water, but dissolving very readily in 40 parts of absolute alcohol. Its composition is $C_{18}H_{20}NO_4+H_2O$. If placed on the tongue it occasions a burning sensation, which masks for the moment the decided bitterness. In a small dose it produces sleep, but in larger quantities it occasions coma and death by paralysis. The ingestion of 0·05 grm. brings on symptoms of poisoning; 0·1 grm. is a dangerous dose for a man, and quantities of 0·1 to 0·05 grm. prove fatal to dogs, cats, &c., in about four hours. Hopeine is a powerful antiseptic, and arrests fermentation. It is hoped that it may prove of service in the treatment of zymotic diseases.—*Dingler's Journal.*

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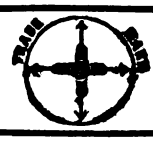
Quality Guaranteed by Name and  *Trade-mark on Original Packages.*

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THE CHEMICAL NEWS.

Vol. LIV. No. 1405.

ON THE NATURE OF SOLUTION.*

By SPENCER UMFREVILLE PICKERING, M.A.,
Professor of Chemistry at Bedford College.

The "hydrate" theory attributes dissolution to the existence, in a stable or partially dissociated condition, of definite liquid compounds (generally unknown in the solid form) of the substance dissolved and its solvent, and the mixing of these compounds with excess of the solvent.

In certain special instances we have direct evidence of the reality of such compounds,† but it is on general grounds rather than on any special experiments that I would seek to establish their existence.

There is, in the first place, a strong *prima facie* improbability that substances such as copper sulphate, potassium hydrate, &c., which possess such an intense affinity for water, should be capable of existing in the anhydrous condition in the presence of an unlimited amount of water.

We know, moreover, that in a great number of cases—where a dehydrated salt is placed in water—hydration does undeniably precede dissolution,‡ and in such cases the salt can only exist in the liquid in the uncombined state if the continued action of the solvent is to decompose the hydrate which it has just formed. The only two forces by which such a decomposition might be supposed to be effected are (1) the attraction of the bulk of the water present for the few molecules of water combined with the salt; (2) the attraction of this same bulk of water for the (anhydrous) salt molecules. On the one hand, however, it is absurd to imagine that the mass of water molecules possess such a strong attraction for the few contained in the hydrate as to decompose this latter, or, even if they did, that they would ever have given them up to the salt in the first instance; and, on the other hand, it is equally absurd to urge the intensity of the attraction of the salt molecules for the water molecules as a reason for these two parting company.

Another general fact, which lends considerable support to the view that the dissolution of a salt is due to the formation of a hydrate, is, that those salts which *combine* with water always *dissolve* in that liquid, and, as a rule, the greater the energy with which they do combine with it, the greater is their solubility.

The thermal phenomena attending the act of dissolution point incontestably to the same conclusion. When a dehydrated salt (say $MgSO_4$) is dissolved in water a considerable evolution of heat occurs; and by the simplest experiment it can be established, beyond any possibility of doubt, that all, or the greater portion of this heat is due to the hydration of the salt. If the salt be taken in the hydrated condition less heat is evolved, and, without a single known exception, this evolution diminishes continuously as the salt taken is more and more highly hydrated; but even when taken in its most highly hydrated condition the evolution of heat is in many cases still very considerable.* Now unless we can reconcile ourselves to attribute the heat evolution in this latter case to a cause entirely different from that which exists in the other cases,—unless we are content to shut our eyes to the proportionality between the heat evolved and the degree of hydration of the salt taken,—we must admit that even with a fully hydrated solid salt the heat evolved is due to further hydration; that not only do hydrates exist in solution, but that they are often of a higher order than the highest known in the solid condition.

Coming now to the other side of the question, we find many general considerations, as well as special results, brought forward against the hydrate theory of solution. The latter, however, are for the most part, I consider, urged on mistaken notions, and prove nothing *pro* or *con*.

Thus Dr. Nicol's study of the molecular volumes of salts in solution shows that their volumes are entirely uninfluenced by the presence or absence of water of crystallisation in the solid salt; that if any water is still combined with the salt when dissolved it acts in the same way, and is quite indistinguishable from the rest of the solvent present. In so far as his conclusion that these molecular volumes afford no evidence in support of the existence of combined water, I entirely agree with Dr. Nicol; but in concluding that therefore no water is combined, he has pushed his conclusions far beyond legitimate limits. The same reasoning that leads to the belief that the water and the salt bear no chemical relationship towards each other in solution would hold equally good with reference to the radicles of which the salts themselves are constituted, as Favre and Valson indicated in 1875 (*Comptes Rendus*, lxxv., 1000). Each radicle possesses its own specific volume entirely uninfluenced by the nature of the other radicle with which it is combined: the radicles behave independently, and as if there were no combination between them.

Nor is it only from a study of the volumes of salts in the dissolved state that such results are obtained. Numerous determinations of the extent to which the vapour-pressure, the freezing-point, and the temperature of maximum density of water is influenced by the presence of various salts in it, have been made by Wüllner, Blagden, Dufour, Depretz, Rüdorff, and De Coppet,† with the general results that certain hydrates of the salt are in some cases present and in others the salt is anhydrous; but these conclusions, which would tell more against the hydrate theory than for it, are eminently unsatisfactory. The whole question, however, has been reopened by Raoult (*Ann. Chim. Phys.*, (5), 28, 133; (6) 2, 66, 4, 401); and by an exhaustive extension of the work, and by including solvents other than water, and solids other than salts, he has thrown a new light on the subject. Not only does the salt, in its influence on the freezing-point, show no signs of the presence of combined water, but it shows no signs of itself being a single compound; each of the radicles contained in it acts independently of the other, and in precisely the same manner as a *molecule* of a non-saline substance (see especially *loc cit.*, 4, 426). Precisely similar conclusions as to the apparent non-combined state of radicles in a dissolved salt were arrived at by Valson in his work on capillarity (*ibid.*, 1870) and by Hugo and Vrié (*ibid.*, 1883) in their examination of the effect of membranes on salt solutions. Other instances of a similar nature, physical and thermo-chemical, might be quoted.

That atoms or molecules which are undoubtedly united may retain their individuality so far as to act towards

* Discussion on the "Nature of Solution." British Association, Birmingham Meeting, Section B.

† See especially Berthelot, *Ann. Chim. Phys.* (5), 4, 445 to 537.

‡ Dr. Nicol (*Phil. Mag.*, 1885, i., 453, and ii., 295) quotes experiments with sodium sulphate in opposition to this view. He shows that the dehydrated salt may dissolve in water under certain circumstances without any signs of previous hydration. When it does so, however, it forms a supersaturated solution, which is certainly very different from a normal solution, being, according to Dr. Nicol's determination of the solubility, due to the extension at lower temperatures of conditions which exist naturally only above 33°: but when it dissolves to form a *normal* solution it is with evident signs of hydration. Whatever this may prove as to the supersaturated solution, it certainly does not prove that the normal solution contains the anhydrous salt,—rather the opposite.

* Thus the "true" heat of dissolution of $MgSO_4 7H_2O$ is +7000 cals., and even this number is probably 1000 to 3000 cals. too low, as it contains no allowance for the heat of fusion of the $MgSO_4$ molecule. (See *Chem. Soc. Trans.*, 1886, 279.)

† For a general summary and discussion of the results from the point of view of these physicists, see De Coppet, *Ann. Chim. Phys.*, (4), 23, 366; 25, 502; and 26, 98.

certain agents as if they were free, is surely not surprising; and from such methods as would lead us to conclude that the very radicles composing a salt are uncombined, it would be useless to look for evidence of the more feeble combination of the salt with its water, and inconsistent to argue, from the absence of such evidence, that no combined water is present.

Although I am not inclined to attribute any weight to these special experiments brought forward against the hydrate theory, it is otherwise with more general considerations.

The formation of hydrates cannot explain the absorption of heat which in many cases accompanies dissolution. The phenomena of solution are too universal to permit of imagining the existence of some definite compound of the dissolved substance with the solvent in every case. There is a continuous influence exerted by the salt on its solvent too extensive to be accounted for by the effect of mass on partially dissociated hydrates; there is a continuity between the fused and dissolved states in many cases, and a regularity in the variation of solubility with change of temperature, &c., which cannot be thoroughly explained on the hydrate theory.

However undeniable the existence of these compounds may be in many cases, they do not give an adequate explanation of all the facts of dissolution.

The hydrate theory can be neither rejected nor accepted.

The explanation of this contradiction is not, I think, very difficult to find. We are talking about molecules of solids and liquids, not as they exist, but as they do *not* exist. Our chemical formulæ for them represent but the results of analysis, or, at the most, the constitution of the substance in that transitory state of simplification which immediately precedes entire decomposition; what their composition may be when in the free state, and removed from all decomposing forces, we know not: all we do know or believe about them is, that they are then far more complex than chemical formulæ represent.

Crystalline form alone would show that a number, probably a very great number, of our so-called molecules combine together, bear certain definite relations and hold certain definite positions towards each other, producing a molecular aggregate or physical unit, which alone should receive the name of molecule.*

Just as a number of similar particles unite to form an aggregate or true molecule of any simple substance, so will dissimilar particles unite to form aggregates of a more complex nature.

It is but natural that our prejudices in favour of the "laws" of chemical combination and atomic valency, to which we owe so much, should lead us to attribute the variable composition of certain substances to our imperfect means of investigation rather than to the non-conformity of these substances to our laws. Whether we be right or not in our explanation, we must acknowledge that apparent *in*constancy in composition is one of the most marked features of immense classes of substances which cannot be termed other than chemical compounds.

The varied composition of minerals is said to receive an explanation in the statement that isomorphous substances may displace each other in definite proportions, but to an indefinite extent. This is undoubtedly true, but it does not obviate the necessity of recognising the existence of some form of attraction between these isomorphous substances. No purely mechanical or physical cause can explain this phenomenon; mere similarity of crystalline form has been proved to be incompetent to produce such results. A selective power is exhibited by the substances which thus unite,† as well defined as that selective power which in the case of simpler substances has received the name of chemical affinity, and the resulting compounds are characterised by the same uniformity in composition and physical properties‡ which is the attribute of acknowledged chemical compounds.

Nor is it with minerals and artificial crystals only where we find ourselves in what would appear to be a wide border-land between chemical compounds and mixtures. Whether we study the formation of alloys, the occlusion of gases by solids, ranging from the most mechanical action by insensible graduations to the formation of a substance having every appearance of a definite compound, or the decomposition of some of the firmest chemical bodies by so-called mechanical means (filtration), or the constant change in composition of many basic salts with change in the circumstances of their formation—we are forced to admit that the definiteness which characterises the combination of atoms may be absent from, or at any rate unrecognisable in, the combination of our so-called molecules to form complex aggregates.

When we examine the constituents of these apparently indefinite compounds, it becomes clear that it is only substances which resemble each other which can combine in this manner; and one of the most striking features of dissolution offers such a strict parallel to this, that its meaning can scarcely be mistaken.

A certain degree of similarity in nature between the solvent and the substance dissolved is the invariable accompaniment of dissolution.

Dissolution, I believe, is but one of the many results of apparently indefinite chemical combination.

We cannot obtain a satisfactory explanation of the composition of minerals by admitting the existence of *definite* double salts only, nor can we explain the phenomena of dissolution by confining out attention to *definite* hydrates only. These may, and in all probability do, exist in solution, but they are only small circles within the larger ones; their successive formation and decomposition would give rise to irregularities and effects such as those which are observed in some cases; but these irregularities would form but ripples on the more regular changes which would accompany the variations in the molecular aggregates,—variations which, as in the case of minerals, would be so dependent on physical conditions as to obliterate their chemical nature when examined from many points of view.

The evolution of heat accompanying dissolution will still be attributable, as on the ordinary hydrate theory, to the formation of chemical compounds, but the far greater complexity, and, consequently, instability of these, than of atomic hydrates, if I may so call them, will remove all difficulty in comprehending the continuous effect of the mass of the solvent upon them, even when the latter exceeds that of the salt many hundred fold; where heat is evolved, therefore, the evolution will be increased, though at a diminishing rate, by dilution.

The rapid increase in the heat of dissolution, produced by a rise of temperature, is but a necessary consequence of the formation of a chemical compound possessing a specific heat less than the sum of those of its components, and would of itself go far to prove that a solution did in reality contain such a compound. But a rise of temperature would also undoubtedly have another and opposing effect, for, being inimical to the complexity of these hydrates, they would be more dissociated at higher than at lower temperatures, and hence the heat of dissolution would not be so great as it should be according to the

* In a Paper read before this Section last year (Report, p. 989), I argued that our formulæ adequately represented the molecules of solids and liquids with which chemical reactions deal, although I fully recognised the existence of far more complex aggregates: my opinions have so far altered that at present I consider these aggregates to be recognisable in many operations which must be termed chemical, although in the great bulk of ordinary reactions the simpler or ultimate molecules need alone be considered.

* A power or "affinity" so strong that it will sometimes induce a salt to separate out in a crystalline form and with a proportion of water foreign to its nature, as well as from a solution too weak to yield it of its own accord (Aston and Pickering, "Multiple Sulphates," *Chem. Soc. Trans.*, 1886).

† J. M. Thomson, on the "Double Sulphates of Nickel and Cobalt" (*Brit. Assoc. Rep.*, 1877, 209).

various specific heats. This is precisely what Dr. Tilden has proved to be the case (*Proc. Roy. Soc.*, 1885, 401).

There is, however, another action which I believe accompanies every act of dissolution resulting in the *absorption* of heat.

The heat absorbed by a large number of salts in dissolving can not be freely accounted for by the mere physical change of the solid into the liquid salt. Thus, the heat of dissolution of potassium nitrate is − 8500 cal., and that of sodium nitrate −5000 cal., whereas the heat of fusion of these salts at the same temperature is but −1300 and −2300 cal., respectively. There must be some other heat-absorbing action besides the fusion of the salt. The amount of heat thus absorbed increases also with the dilution of the liquid. Moreover, we cannot, I think, account for the manner in which heat is evolved in one case and absorbed in another, or the way in which an absorption of heat sometimes gives place to an evolution, as the temperature or other conditions are changed, but by admitting the constant coexistence of two actions producing opposite thermal effects, and being influenced to different extents by an alteration of circumstances.*

On the theory which I am here advocating this absorption of heat receives a ready explanation. Whatever be the complexity of the molecular aggregates of a liquid, those of a solid will be still more complex. Fusion would, therefore, entail their simplification; it would be but a chemical decomposition absorbing heat; this simplification would be pushed much further, however, when the salt is dissolved instead of being merely fused, for the particles of the liquid act chemically (*ex hyp.*) on those of the solid and combine with them themselves; the cold absorbed on dissolution would exceed that absorbed on fusion, and would, moreover, be increased by increasing the amount of the solvent. This accords fully with the facts observed.

All the phenomena attending dissolution are, therefore, I contend, accounted for by a full recognition of the real complexity of the units of matter, and by taking the more liberal view of chemical combination which is inculcated by a study of minerals and other substances. Every act of dissolution involves two actions. The chemical decomposition of the more complex aggregates of the solid into a simpler form, absorbing heat, and a chemical combination of these with the liquid, evolving heat; the only quantity which we can at present measure is the algebraic sum of these two.

Mr. Durham next gave a short statement of his own theory of solution:—

When, for example, common salt (NaCl) is placed in water, all the atoms act upon each other. The sodium of the salt acts upon the oxygen of the water, and the chlorine of the salt upon the hydrogen of the water; and the result is a definite compound, which we call a solution. The heat of formation of the acid is neutralised by the heat of formation of the oxide. If they be not equal, the difference is the heat of the solution; if they be equal, the heat is of course *nil*. If the former be the greater, the heat of the solution is negative; if the latter, it is positive. Solution arises from chemical affinity, and takes place inversely as the attraction between the positive element and the oxygen—and the negative element and the hydrogen—of water. But chemical affinity is itself physical; the atoms are physical, and all forces which act upon them must be physical forces. In a chemical mixture every atom is acting upon every other atom, but such action can be nothing else than physical; and we are therefore led to the conclusion that there is really no difference between chemical and physical action, and, consequently, that the alternative between the two does not exist.

In the course of the "Discussion on the Nature of Solution," and preceding the reading of Mr. Pickering's paper, the following remarks were made:—

Dr. Armstrong said that, from the summary given by Prof. Tilden, it appeared that the two important questions for discussion were—(1) Does water of crystallisation exist in solution combined with the salt as it did prior to dissolution? and (2), What distinction is to be drawn between chemical combination and mechanical association or adhesion? In short, are the phenomena of dissolution of a chemical or of a mechanical character? But Prof. Tilden had made an important omission, inasmuch as he had not discussed the possible simplification of the molecules on dissolution: in discussing the evidence afforded by the various phenomena, everything turned upon the question whether the crystal molecules are of the composition represented by our ordinary formulæ, or are more or less complex.

As regards the first question. Prof. Tilden appeared to differ from Dr. Nicol, and to think that water of crystallisation did exist in solution. (Prof. Tilden, interposing, desired to explain that what he had said was that it was impossible, in the case of any solution, to say that one portion of the water is in combination with the salt and that another is not; all the phenomena of dissolution and dilution being continuous, no point can be found at which such a distinction can be set up. He believed that the salt was attached to all the water present without exception.)

Dr. Armstrong, resuming, said that much of the evidence appeared, he thought, to favour the conclusion that in certain cases water of crystallisation did exist in solution; *e.g.*, the difference in colour between many hydrated and dehydrated salts taken in conjunction with the colour of their solutions. Again, many dehydrated salts dissolved much less readily than the corresponding hydrated salts: instances of this kind were not common among inorganic salts, but were often met with among organic salts, and the speaker cited calcium butyrate and certain naphthalene- and naphthol-sulphonates as examples. Dextrose, again, ordinarily crystallises with two molecules of water, but if dehydrated and carefully dissolved in water at a low temperature it may be crystallised out from the solution in the anhydrous state. T. Thomsen's recent experiments, however, appeared to show that when two substances were dissolved in water they appropriated the water in the proportions in which they were present, thus favouring a purely mechanical interpretation of the phenomena of dissolution; but, on the other hand, it was to be noted that in the case of citric and sulphuric acids, for example, Thomsen's results were in accord with this conclusion only when it was assumed that the citric acid was present as the dihydrate and sulphuric acid as the monohydrate, $H_2SO_4.OH_2$. In fine, the speaker was of opinion that while the question could not be regarded as settled, yet there was a considerable amount of evidence that the water was not evenly distributed, but was, in some cases at least, in part directly combined with the dissolved substance. Dr. Nicol had deduced an ingenious argument from J. Thomsen's observations on heats of neutralisation. As a criticism of Dr. Nicol's argument from the existence of neutralisation constants he would venture to say "Put not your faith in constants." If the views which he held —views which probably were at present peculiar to himself—were correct, the quantities in question ought to have a constant value. According to Helmholtz, all atoms hold a positive or negative electrical charge, a single charge being associated with a monad, two with a dyad, and so on. If when combination takes place these charges exactly neutralised each other, all compounds would be neutral and saturated; but actually this is not the case: in point of fact, there is no such thing as a saturated compound.

* A study of the thermal results attending the dilution of salt solutions, established by Thomsen ("Thermochem.," iii., especially plate iv., and also the curves given by formic and acetic acids and by potassium and sodium hydrates), impresses very forcibly the coexistence of these two actions, although Thomsen himself does not seem to have noticed it.

Helmholtz seems to think that the charges may be held by different atoms with different degrees of force, but the speaker took a somewhat different view, and thought that probably when two atoms combined, in consequence perhaps of peculiarities of structure, their charges were not completely used up; the resulting molecules therefore possessed a certain residual charge or affinity, and were consequently in a position to enter into combination with other molecules. Thus water, he thought, was not a saturated compound; its oxygen atom was still possessed of residual affinity. The same was true of sulphuric acid. Consequently the two could combine together to form a hydrate. On neutralising a dilute solution of alkali by a dilute solution of acid, a stable condition is finally attained, and it is to be assumed that the affinities are fully satisfied, or very nearly so—that the charges practically neutralise each other: hence it may be expected that the heat of neutralisation will have nearly a constant value provided there be no disturbance such as the separation of a precipitate would produce. But the value of each of the several processes which go to make up the heat of neutralisation are entirely unknown to us, and in the absence of such knowledge it is impossible to place much confidence in arguments based upon the study of such complex phenomena.

As regards the question of chemical *versus* mechanical action, the speaker could only imagine one form of mechanical action attending dissolution, viz., that of the water molecules bombarding the surfaces of the solid, and as it were chipping off particles. All other actions, in so far as they could be regarded as involving the attraction of the molecules of the dissolved substance by those of the solvent, he was inclined to class as chemical. Nothing was more certain than that dissolution depended both on the nature of the solvent and of the substance dissolved. Like dissolves like—water is *the* solvent for bodies containing oxygen; sulphur compounds are dissolved by carbon bisulphide; phosphorus compounds by chloride of phosphorus; shale spirit, which is rich in olefines, and especially rosin spirit, which is rich in acetylenes and benzenes, were far better solvents of hydrocarbons and resinous bodies than petroleum, which consisted of saturated inert hydrocarbons, and was the worst of solvents. Facts such as these spoke strongly in favour of the conclusion that the phenomena of dissolution are largely of a chemical character.

Prof. W. N. HARTLEY was understood to base the argument in favour of the hydration theory chiefly on the changes of colour observed in the solution of certain salts in various proportions of water. The chlorides, bromides, and iodides of cobalt, nickel, and copper exhibit these phenomena most plainly. Thus the iodide of cobalt in the anhydrous state is black, its dihydrate is green, the hexhydrate a reddish brown. If this last be dissolved in water a pink solution is formed, which probably contains a richer hydrate. The brown saturated solution of the hexhydrate is a very dense liquid, of specific gravity about 3, and when water is added to it the formation of the pink liquid is attended by a large evolution of heat, and this affords evidence that the hydrate exists in the solution. Again, hydrated cupric chloride contains two molecules of water, and when quite dry is of a pale blue colour. Its solution in water has the same colour unless it be heated, and then it turns green. Nickel salts behave similarly. So that the evidence, on the whole, warrants the belief that when a hydrated salt is dissolved in water the water of crystallisation remains a constituent part of the molecule.

Dr. GLADSTONE commenced his remarks by a discussion of the question, What is a salt in solution? Is the solution of a salt in water a process analogous in any degree to the decomposition which takes place when one salt is mixed with another? Take, for instance, chloride of sodium and water. Many years ago the speaker had endeavoured to determine whether any chemical decomposition of the salt by the water occurred so as to give rise to sodium hydrate and hydrochloric acid, but he had come to the conclusion that this decomposition took place, if at all, only to a very small extent. Many salts, as had already been stated, combine with water to form coloured hydrates, and the hydrate is of a colour different from that of the anhydrous salt. But a coloured hydrate, when dissolved in a sufficient quantity of water, is never changed by further dilution. The speaker had endeavoured to ascertain whether the specific refraction of substances was altered by solution. He had found that no alteration could be detected, and this result was afterwards confirmed by the experiments of other chemists. The refraction equivalent of a solution is equal to the sum of the refraction equivalents of the salt and the water present. In an alum solution, the water of crystallisation supposed to be in combination with the salt is not distinguishable by its refractive power from the water of solution outside it. It seems impossible, however, to arrive at a conclusion with regard to the constituents of a solution. The idea of reciprocal decomposition is not supported by experimental evidence, save in some exceptional cases, and the actual condition of a dissolved salt seems beyond expression by formulæ.

A NEW PROCESS FOR THE PRODUCTION OF THE ALKALI METALS.*

By HAMILTON Y. CASTNER, of New York.

I SHALL first proceed to give a brief description of the process heretofore employed for manufacturing the alkali metals, together with the defects of the same, which prevent an economical production of metal, before explaining the method I have invented for their reduction, and its advantages over the older process. Although in the following paper mention is only made of sodium, the same remarks are intended to apply to potassium, the process being practically alike in the production of either metal. The method formerly used consists in igniting, at an intense heat, an intimate mixture of nine parts of sodium carbonate, four parts of charcoal, and one part of lime in wrought-iron vessels, cylindrical in form, placed horizontally in a furnace, the said cylinders being furnished with a small tube to conduct the metallic vapours and gases produced during the reduction, into the attached condenser, wherein the vapours are condensed and the sodium obtained. The cylinders must be constructed of wrought-iron, this being the only metal possible to use that will stand the heat, and the dimensions of the same must not exceed a diameter of six inches or a length of five feet. The mixture of sodium carbonate, charcoal, and lime must be finely ground and calcined, to render it more compact, previous to placing it in the cylinders. Lime is added to make the mass refractory, otherwise the alkali would fuse when the charge is highly heated, and separate from the light infusible carbon. The carbon must be in the proportion to the sodium carbonate as four is to nine, which is found needful in practice, so as to assure each particle of soda in the refractory charge having an excess of carbon directly adjacent or in actual contact. Notwithstanding the well-known fact that sodium is reduced from its oxides at a degree of heat but slightly exceeding the reducing point of zinc-oxide, the heat necessary to accomplish reduction by this process and to obtain even one-third the metal contained in each charge, closely approaches the melting-point of wrought-iron. Any process devised for the manufacture of sodium, by which its cost could be reduced, would have to be an improvement over the older method in one or more of the following directions, namely:—

(1.) The process should be more simple in its details,

* A Paper read before the Chemical Section of the Franklin Institute, October 12th, 1886.

and not require the care and management necessary in carrying on the process or method now used.

(2.) Performing the reduction at a comparatively low temperature and so save in the fuel and prevent the excessive destruction of iron, which at present stands for one-half the cost of the sodium produced.

(3.) By increasing the yield of sodium, as in the old process, when one-third the metal contained in the charges is obtained, the result is considered very satisfactory.

The process which I employ consists in reducing either the hydrate or carbonate of an alkali, when in a fused state, at moderate temperatures, by the use of the carbide of a metal or its equivalent, whereby an excess of carbon is avoided and the use of lime is rendered unnecessary. The reducing substance, due to its composition and gravity, remains below the surface, and is therefore in direct contact with the fused alkali. By the equivalent of the carbide of a metal, I mean a mechanical compound of carbon and metal from which the metal cannot be separated, excepting by the aid of acids or intense heat. Such a compound I produce by coking a mixture of tar and iron (previously reduced in a fine state of division by carbonic oxide or hydrogen). From experience such proportions of tar and iron are used as will produce, when the mixture is coked, a heavy mass of metallic coke, having about the composition of, iron 70 per cent and carbon 30 per cent, equivalent to the formula FeC_2. This mechanical compound, after being ground, is ready for use, and consists of fine particles of iron, coated with carbon, fully answering the purposes of a true carbide. I prefer to use caustic soda in the preparation of sodium, on account of its fusibility, and with it mix such quantity of the so-called "carbide" that the carbon contained in the mixture shall not be in excess of the amount theoretically required to reduce all the soda to sodium, according to the following reaction:—

$$3NaHO+FeC_2=3Na+Fe+CO+CO_2+3H;$$

or, to every 100 pounds of pure caustic soda, fifteen pounds of "carbide," containing about twenty-two pounds of carbon, is added. The treatment of this mixture is carried on in large cast-iron crucibles, in a furnace, the general arrangements of which are as follows:—The heating space of the furnace is divided into separate chambers, the dimensions of the same depending upon the size of the crucibles to be heated, and the number of these compartments are in proportion to the capacity of production desired for the furnace. An aperture is provided in the bottom of each chamber, through which the crucible may be raised by mechanical means into its position in the furnace. The necessary cover for the crucible is fixed stationary in each chamber, and from this cover projects the tube to the outside of the furnace into the receptacle for the condensation of the metallic vapours. When operating the crucibles are charged with the mixture, made as before described, placed upon the lift, which is situated directly below the aperture made in the bottom of the chamber, and raised into the furnace. The edges of the covers are made convex, while the edges of the crucibles are concave, so that when the crucibles are raised the edges come together, and, being held from below, form a tight joint, preventing the exit of gas and vapour, excepting through the tube provided from the cover. Gas, which is used as a fuel in connection with heated air, is allowed to enter the chamber after the crucible containing the charge is in place, and the reduction and distillation commences as soon as the crucible contents have reached the temperature of 1000° C., the sodium being reduced in the crucible and distilled therefrom into the condenser by passing through the tube projecting from the crucible cover. As soon as the operation is finished, the crucible is lowered and a new one containing a fresh charge is raised in its place, while the crucible just removed is cooled, cleaned and recharged. The appliances which hold the cover in place are so arranged that the cover may be removed whenever necessary without interrupting the process, which is practically continuous. By avoiding the careful mixing and calcining of ingredients, preparatory to charging the cylinders, and in carrying out generally the mechanical part of the old process, the details of which require the most careful management, the method just described will be seen to have many advantages. As the charge is fused, the alkali and reducing material are in direct contact, and this fact, together with the aid rendered the carbon by the fine iron, in withdrawing the oxygen from the soda, fully explains the chemical reasons why the reduction is accomplished at a moderate temperature. Furthermore, by reducing the metal from a fused mass, in which the reducing agent remains in suspension, the operation can be carried on in crucibles of large diameter, the reduction taking place at the edges of the mass, where the heat is greatest and the charge flowing thereto from the centre to take the place of that reduced. By the old process, the heat required to penetrate to the centre of the refractory charge, and reduce the soda there situated, in addition to the heat absolutely needful to bring about reduction, necessitates the use of wrought-iron vessels, and even when these are made small in diameter, which partially removes this great disadvantage of the method, the expensive cylinders are rapidly rendered worthless from the effects of the intense heat.

In doing away with the use of lime and an excess of carbon, the main causes which have hitherto prevented a full yield of metal are removed, and thus, with the aid of other advantages described, I am enabled to obtain fully 90 per cent of metal, instead of 30 per cent as formerly. By the old process lime must be added, to prevent fusion, to insure any reduction, yet at the same time it forms, with a portion of the soda, the compound known as soda-lime, and from this substance carbon reduces sodium only at the most intense heat. In practice, according to the old method, four pounds of carbon are used to every nine pounds of sodium carbonate. This is twice the amount theoretically required to reduce all the sodium, even assuming the gas resulting from the reduction to be wholly carbonic oxide. When, however, but one-third the total amount of sodium is all that is obtained from a charge, the proportion between the sodium produced and carbon used becomes as one is to six. The effect of an excess of carbon in the mixture, which, as previously explained, is really necessary, is to produce an excessive amount of carbonic oxide, and this, together with the excess of carbon, combines with the metallic vapours of sodium, forming various compounds, from which the metal cannot be distilled. By reducing caustic soda with the carbide of a metal, or its equivalent, and using only sufficient carbon to carry out the reaction stated above, the gases given off consist of hydrogen, carbonic oxide, and carbonic acid, which mixture has little or no effect upon the vapours of sodium. The crucibles, after treatment, contain a small amount of carbonate of soda and all the iron of the "carbide" still in a fine state of division, together with a very small percentage of carbon. These residues in the crucibles are treated with warm water, and the solution of soda evaporated to recover the carbonate of soda, while the fine iron is dried, mixed with tar, and coked to produce more of the so-called "carbide equivalent."

The Composition of Urine after the Internal Use of Oil of Santal.—C. Mehu.—After the internal use of the essential oil of santal there is found in the urine a resinous matter of santal-like odour, and it appears to be held in solution by sodium phosphate, which plays the part of a weak acid. The oil of santal, if pure, does not impart to the urine a smell of violets.—*Journal de Pharmacie et de Chemie.*

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 208.)

2. *Micro-Chemical Methods.*

We have often felt inclined to turn for help to chemistry, which, in the hands of Klaproth, Berzelius, Rammelsberg, and others, has been of such immense service in the determination and classification of minerals, and we should doubtless at the present time possess a complete system of micro-chemical methods of determining the more common minerals if they were as easily attacked by chemical reagents as even the most refractory organic tissues are. The morphological reagents (acetic acid for the interior of the cells, and potash for the envelopes) are of no use in the examination of minerals, on account of not being able to soak in.

The application of methods based on colouration can only be of very limited use, inasmuch as there are but few minerals which have the property of absorbing colouring-matters, and above all of fixing them. Maceration with acids and saline solutions seems to promise better results, but up to the present this method has been so little used that it is impossible to make it the basis of a rational system of analysis.

The treatment of minerals by means of hydrochloric acid, of which we have already made mention (1), may be considered a s resulting from this general method. As a rule we take some of the powdered mineral to effect this, but the results are not easy to decipher. It is, in fact, only necessary to remember the numerous cases where this process, because of the confusion of microscopic images, has led to contradictory statements as to the nature of the substance, and has given rise to serious doubts as to the value of the method. Let us further remark that hydrochloric acid applied in the ordinary manner, that is to say, in an aqueous solution more or less concentrated, to very thin plates, often leads to the total destruction of the material under examination.

From what has preceded we draw this conclusion, that we cannot arrive at a positive result by this method without entirely destroying a certain portion of the silicates, either by acting on a restricted portion of the polished surface, or by attacking, by the reagent, a picked sample of the mineral, and applying the regular rules of qualitative analysis.

M. H. Rosenbusch, who has often made use of chemical reagents as auxiliaries, recommends, in his "Physiographie Microscopie" (vol. i., p. 108) the simultaneous application of the chemical and optical methods, and even gives (pp. 107 to 111) some instructions as to the micro-chemical manipulation, on which we can make successful use in divining the nature of minerals. The principle of his method, applied either to the powdered mineral or to thin plates of the substance, can be condensed as follows:—

1. Partial dissolution by acids or alkalies of the integral matter, and qualitative analysis of the substance dissolved according to recognised methods, availing oneself of the microscope when necessary.
2. Microscopic examination of the residue, immersed in Canadian balsam.

M. Rosenbusch's method necessitates the use of filters. The filtering apparatus described by him would no doubt serve to reduce, as much as possible, the loss of time in this kind of research, as well as the still more deplorable loss of material; but it must be admitted that it would be very desirable to substitute another method by which a qualitative analysis could be done without having recourse to filtration.

3. *M. Boricky's Method.*

M. E. Boricky has the merit of being the first who has published a rational system of micro-chemical reactions. He tries in every case to do without filtration, and he uses but one principal reagent. It is this that gives a real advantage and an elegance to his method which reflects great credit on him.

M. Boricky based his "*universal method*" on the property of hydro-fluosilicic acid of being decomposed by evaporation and forming hydrofluoric acid, and giving, with alkalies, crystalline salts, very slightly soluble and of a very distinct form. He submits to evaporation hydro-fluosilicic acid at 3½ per cent, in contact with fragments of minerals, or with the polished surface of a stony material,* and he distinguishes the fluosilicates formed by means of their crystalline forms.†

The potassic salt forms cubical crystals; the sodic salt hexagonal prisms, crowned with a pyramid, with obtuse angles. The calcic salt is found in the form of rods, and the magnesic salt as rhombohedrons. The strontic compound resembles the calcic, while that of barium gives little pointed needles, and that of lithium small six-sided pyramids. The observations were made under a magnifying power of from 200 to 300 times.

To distinguish calcium from strontium M. Boricky uses sulphuric acid diluted with its own volume of water.‡ By this reagent the crystals of fluosilicate of calcium change into masses formed of crystals of gypsum, whilst the fluosilicate of strontium is transformed into a granular mass hardly recognisable.

Fluosilicate of sodium is not attacked by sulphuric acid. To distinguish between the fluosilicates of magnesium, iron, and manganese, they are treated either with chlorine or with sulphide of ammonium: under the influence of chlorine the ferrous salt takes a light yellow colour, and the manganese salt becomes of a reddish tint, while the sulphide mentioned colours the ferrous salt black, and precipitates from the solution of the manganous salt a greenish grey substance, having a granular appearance. It is well understood that the magnesic salt is unaffected by either of the above-mentioned reagents.§ As to the application of the other reactions indicated by the author (experiments with heat and the corrosion of polished plates), I must refer the reader to the original; only I will here take the opportunity of remarking that several of the phenomena attributed by the author to the action of chlorine might very possibly be caused by the action of hydrochloric acid vapours.

M. Boricky has proved, by several controlling experiments, that it is possible to obtain very good results by employing his method, and, as far as I am concerned, my own trials have confirmed this. If, however, in spite of this success, I have found it necessary to stray a little from the rule he lays down, it is because it contains some grave faults, which can only be found by practice, and that it is not always easy to apply.

It is this which caused me successively to examine the method more closely, to complete, and then to modify it. The experience which serves to show the presence of alkalies leaves little to desire as to manipulation, but much as to ease of carrying out.

The manner of carrying it out is simple; it is to let a drop of hydro-fluosilic acid dry on a polished plate of the mineral. In this experiment, white crusts are formed which are hardly transparent,‖ and often do not allow us

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* E. Boricky, *Elements einer neuen Chemisch-mikroskopischen Mineral- und Gesteins analyse*, p. 15 and following, in the *Archiv der Naturwissenschaftlichen Londesduchforschung von Böhmen*, Bd. 3, Abth 5.

† *Ibid.*, p. 17 to 22.

‡ *Ibid.*, p. 22.

§ *Ibid.*, p. 23.

‖ *Ibid.*, pp. 15, 16. The author asserts that the silicic acid separates in considerable quantities in a concentrated solution of hydro-fluosilicic acid. In this case he finds himself forced to have recourse to potash to dissolve the jelly, which is only partially successful, while the addition of concentrated sulphuric acid would give a satisfactory result. It results from this that the matter which is separated is not silicic acid, but we have to deal with the rapid formation of fluosilicates, and, in the greater number of cases, with the formation of fluoaluminates, difficult to decompose.

to distinguish the adjacent white crystals, notably those transparent ones of fluosilicate of potassium. We obtain much better results by drenching the little masses of mineral in drop of acid (p. 15), because then a part of the fluosilicates formed is shown distinctly on a colourless back-ground, quite transparent. I have always obtained the best crystals by boiling the fluosilicates in water, and placing several drops of the liquid on a plate of glass: this method is used by M. Boricky in his experiments with hydrofluoric acid (p. 31).

(To be continued).

SOME PROCEDURES OF QUALITATIVE ANALYSIS BASED UPON MICRO-CHEMICAL REACTIONS.

Boricky made the first attempt to dispense with filtrations and to use only one principal reagent, hydrofluosilicic acid, which serves to distinguish the bases contained in a silicate. He spreads upon a glass slip a thin layer of Canada balsam, moderately dry, fixes in it by fusion a small fragment of the mineral, and places, upon it a drop of the acid. The action is allowed to go on in the cold for twenty-four hours in a moist place, and the preparation is then left for twenty-four hours longer, still in the cold, in dry air. The bases of the mineral pass into fluosilicates, which crystallise slowly and are examined with the microscope. Those of the magnesian series (magnesium, zinc, manganese, iron, nickel, cobalt, copper) all crystallise in hexagonal crystals and are respectively distinguished by their colour and their behaviour with ammonium sulphide. The process is especially applicable to potassium, sodium, and calcium. Potassium fluosilicate, a sparingly soluble salt, forms regular cubes or octohedra of remarkable limpidity, absolutely monorefringent. The corresponding sodium salt, more soluble, forms hexagonal prisms, sometimes bipyramidal, with a uniaxial double refraction, very slight and negative. The calcium salt is very soluble, crystallising in lamellæ, spindles, or oblique prisms with curvilinear outlines, strongly double refractory.

Th. Behrens has published a method for detecting a large number of elements in a fragment of a mineral less than ½ m.grm. The portion, finely powdered, is attacked in a platinum crucible with a few drops of pure hydrofluoric acid or by ammonium hydrofluoride mixed with hydrochloric acid. He evaporates, re-dissolves in sulphuric acid to decompose the fluorides formed, evaporates again, and finally re-dissolves in water acidulated with sulphuric acid. This drop containing the sulphates is fractionated by means of a capillary pipette and serves for the various assays.

Calcium is recognised by the prisms and needles characteristic of gypsum being deposited as the drop evaporates.

Potassium.—To the drop is added platinic chloride, which gives the usual precipitate in small regular yellow octohedra.

Sodium (and Potassium).—The author uses a reagent, cerous sulphate, which gives crystalline precipitates with sodium and potassium; the former gives granules much finer and less soluble.

Lithium.—After removal of calcium in the state of gypsum the liquid mixed with sodium carbonate gives prisms of lithium carbonate with rectangular apices.

Barium and Strontium are found in the state of insoluble salts at the bottom of the platinum capsule along with excess of gypsum. They are soluble in boiling sulphuric acid. This solution on dilution and cooling deposits first barium sulphate in very small lenticular crystals laid crosswise, then strontium sulphate in crystals similar but much larger, and lastly gypsum.

Magnesium is detected as magnesium-ammonium phosphate.

Aluminium is recognised by the addition of a solution of cæsium chloride, which yields regular octohedra of cæsium-alum, very slightly soluble.

Sulphur.—The substance is converted, if needful, into a soluble sulphate, and chlorides of aluminium and cæsium are added to form cæsium-alum.

Phosphorus and Arsenic are converted, if needful, into soluble phosphate or arseniate, and the ammonium-magnesium phosphate or arseniate is produced. Arsenic is distinguished by heating the substance in a small tube with sodium carbonate and potassium nitrate.

Chlorine may be recognised by the addition of acid lead nitrate. If there is sulphuric acid in the liquid thallium sulphate is used instead, which precipitates thallium chloride in very small regular octohedra or rhomboidal dodecahedra, often in groups and presenting a remarkable refraction. Instead of searching for chlorine in the solution of the mineral it is preferable to distil the latter with sulphuric acid, placing a drop of cold water in contact with the vapours given off, which are thus condensed, and serve for the assays. Bromine acts like chlorine. We may also recognise chlorine by a mixture of platinum and potassium acetates, which give rise to the formation of the double chloride.

Fluorine.—The mineral (previously opened up, if necessary, with sodium carbonate and moistened with acetic acid) is heated with sulphuric acid, adding, if needful, silica or powdered glass. The vapours are condensed under a little platinum lid, moistened with a drop of dilute sulphuric acid. If fluorine is present it passes into the acid in the state of hydrofluosilicic acid. This is deposited upon a slip coated with Canada balsam, and sodium chloride is added. There are then formed rosettes, hexagonal tables, and bipyramidal prisms of sodium silicofluoride.

Boron and Silicon.—We proceed as for the detection of fluorine, but we distil with fluor-spar. The silicon and boron pass into the drops in the state of hydrofluosilicic and hydrofluoboric acids. We add to these drops, as above, sodium chloride, which yields a silicofluoride and a borofluoride, both crystallised in rosettes, tables, and hexagonal prisms. To decide between silicon and boron and to demonstrate the presence of both, if needful, we add potassium chloride, which yields the well-known silicofluoride (see Boricky's process, above) and a borofluoride in narrow plates with acute apices or rhombic crystals, much more soluble than the silicofluoride. If both boron and silicon are present it is well to fractionate the products of distillation, as boron fluoride is evolved only in the second place.

Water is found by heating the fragment in a glass tube with a drawn out point. The deposit is concentrated in the capillary part, and the reaction may be rendered more sensitive by the introduction of a tiny fragment of magenta, which, under the influence of moisture, loses its metallic lustre, giving a red transparent liquid.

M. Streng indicates a method of effecting micro-chemical filtrations and washings of precipitates, operating upon a few drops of liquid. He uses a band of filter-paper arranged on a glass slip slightly leaning; the drop to be filtered is placed at the upper end. He describes also the following micro-chemical reagents:—

Chlorine (and Silver).—Silver chloride is an amorphous precipitate, not characteristic under the microscope, but it becomes so if dissolved in ammonia and allowed to evaporate, when it is deposited in octohedra, cubes, or cubo-octohedra, It may further be heated in strong hydrochloric acid; on cooling silver chloride is deposited in octohedra.

Selenium.—Sulphurous acid is allowed to act upon the drop, when the selenium is thrown down in small opaque grains.

Phosphorus is converted into a soluble phosphate; silica, if present, is eliminated, and the phosphorus is recognised as ammonium phospho-molybdate.

Antimony is converted into a hydrochloric solution and there is added barium tartrate precipitate suspended in water. If antimony is present the liquid, on slow evaporation deposits rhombic crystals of antimony barium tartrate.

Sodium and Uranium.—On adding uranium acetate sodiferous solutions deposit uranium-sodium acetate in regular tetrahedra of a pale yellow. The uranium acetate used must be very pure. Inversely, uranium may be recognised by the use of a solution of sodium acetate.

Lithium.—The author uses sodium phosphate, which yields a precipitate of lithium phosphate in spindles and stellar groups.

Calcium, Strontium, Barium.—Oxalic acid produces in calcium solutions octohedra or rhombic tables; the two metals are distinguished by the action of sulphuric acid upon the crystals. There is nothing similar with barium. Barium solutions yield rhombic crystals with tartar emetic; those of strontia act similarly, but the crystals formed are less soluble. Barium tartrate forms rounded granules, whilst strontium and calcium yield crystals. Potassium ferrocyanide, added hot to a barium salt, form, on cooling, a deposit of barium and potassium ferrocyanide in pale yellow rhombohedra.

M. H. Rosenbusch in his "Microscopische Physiographie," mentions the following reactions:—

Barium chromate, formed by precipitation, quite resembles the crystallites of barium sulphate deposited in hot sulphuric acid.

Glucinum solutions, mixed with platinum chloride, yield, on slow evaporation, crystals of glucinum chloroplatinate in square or octagonal tables, almost colourless and optically negative uniaxial.

Chrome is converted into alkaline chromate, and a solution of silver nitrate is added. Silver dichromate is formed in rhombic tables, often truncated at the obtuse angles, of a hyacinth red and strongly refringent.

Cerium.—Oxalic acid or ammonium oxalate give a flocculent precipitate which crystallises spontaneously in fine needles highly double refractory. In heat there is a formation of rhomboidal tables.

Yttrium and Erbium are also recognised by means of oxalic acid and ammonium oxalate.

Titanium is attacked with potassium disulphate, and the mass is moistened with hydrogen peroxide. An orange-yellow colouration shows the presence of titanium.

Zirconium.—Attack with sodium carbonate at bright redness and dissolve in acidulated water. If zirconia is present it forms small hexagonal tablets.

Tungsten.—The substance is melted with nitre, dissolved in water, and calcium chloride is added. If tungsten is present cubes, square tablets, or bipyramidic prisms of calcium tungstate are formed.

Tantalum and Niobium.—The substance is fluxed with phosphorus salt, taken up in water, and caustic soda is added. There are formed colourless prisms of sodium tantalate or niobate, often grouped in tufts or stars.

Vanadium.—The substance is attacked with sodium carbonate and potassium nitrate, taken up in water, and a little ammonium chloride is added. There are formed navicular or cuneiform crystals of ammonium metavanadiate, double refractive.—*Bulletin des Elèves de M. Fremy* (April, 1886, p. 145).

ANALYSES OF COMMERCIAL FERTILISERS.*

On Thursday, August 26, the Association assembled in the rooms of the Chemical Division of the Department of Agriculture at 10 o'clock, Dr. H. W. Wiley, the President, in the chair.

In calling the convention to order the President read the following letter from the honourable Commissioner of Agriculture to the Executive Committee:

United States Department of Agriculture.
Washington, D.C, August 7, 1886.

Gentlemen,—The results of your deliberations last year, as published in Bulletin No. 7, have proved of great advantage, not only to the chemists engaged in agricultural work throughout the country, but also to the farmers generally.

The existence of such an association as yours is a necessity, and I desire, in every way possible, to promote its efficiency. Permit me, therefore, to extend to you again an invitation to meet at the Department of Agriculture and to offer all the facilities in my power to make your approaching meeting agreeable and successful.

There are still many problems connected with agricultural chemical analysis which demand your serious attention. Permit me also to suggest that it would both be wise and profitable for you to extend the scope of your investigations to other subjects than those immediately connected with the analysis of fertilisers. It seems to me that there is no subject within the scope of agricultural chemical analysis which does not properly fall within the range of your discussions. I am anxious to see all the agricultural chemists in the country participating in your work and contributing to its efficiency.

I hope to be able, as last year, to aid in bringing the results of your deliberations prominently before the people, and promise you every assistance in my power to that end.

Again extending to you the courtesies of the Department, I am, respectfully,

Norman J. Colman,
Commissioner of Agriculture.

To the Executive Committee of the
Association of Official Agricultural Chemists.

Dr Wiley then addressed the convention as follows:—

Gentlemen,—For the second time under its present organisation our Association has met in Washington. It seems proper, in reviewing the work of our society during the past year, to congratulate you on its results. The proceedings of our last meeting, published through the courtesy of the Commissioner of Agriculture as a bulletin of the Division of Chemistry, have had a large circulation and have attracted much attention. It is gratifying to us to know that this bulletin was reproduced in full in the Chemical News, and received favourable mention in many other scientific journals. But it would be idle to think that the work so well begun is already perfect. A first step forward has certainly been taken, but the road before us is still a long one. Were it not so, the necessity of this and future meetings would not exist. But the success which has already attended our efforts has been great enough to warrant further exertion and give hope of greater achievements. It is evident to every one, however, that in our annual meetings, extending over a period of only a few days, little can be done except to bring together results and compare experiences. The patient and laborious work which alone can give a solid basis for the business of this association must be done in our laboratories and repeated until it gives a sufficient proof of its accuracy. Happily the methods adopted by our committees secure the accomplishment of this work in the most thorough manner, and I doubt whether any other such system of determining the value of any analytical methods is practised anywhere else in the world.

In looking over the means used in other countries to secure uniformity in the application of analytical methods, we may find many valuable indications to help us in the work which we have undertaken. In France we find an association of chemists devoted to the interests of sugar production and of the manufacture of alcohol. This association has adopted processes of analysis for the examination of fertilisers which they have recommended for use. Already two bulletins have been issued by this body, the second of which is a neat little pamphlet of 43 pages de-

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

voted to a discussion of the best methods of estimating phosphoric acid in fertilisers.

The treatment of the subject is in greater detail than the reports of the various Committees of this Association, which have had the subject in charge, but I doubt whether the practical results obtained have been any greater than those achieved by the labours of our own members, who have had this subject under special consideration. Since some of our number may not have seen the results reached by the French Committee, I will give a brief summary of them here. The Committee in charge of the work consisted of the following eminent agricultural chemists :— MM. Déhérain, Joulie, Aubin, and Dupont. Attention is first called to the importance of taking the sample; an importance which is fully recognised by this Association, but which perhaps has not been fully set forth. The French chemists recognise two kinds of samples, commercial and analytical. The commercial sample should be taken from various parts of as large a quantity of the fertiliser as is accessible, and by a person neither interested in the purchase nor sale of the substance. Then it is directed to proceed as follows :—

If it is fine powder, as ground phosphates in certain manures, it suffices to pass it two or three times through a sieve with very small meshes, 1 m.m. for example, being careful to grind the material each time in order to pulverise the fragments which the sieve may retain. Spread out the whole in a thin layer on a large sheet of paper and take here and there with a spatula small portions, which will give a quantity of 20 grms., from which is taken, afterwards, the sample to be assayed.

If the sample is in more of less large pieces like those of the rock phosphates, or coarsely pulverised like those of guanos containing conglomerated particles, it is necessary first to reduce it to powder by passing it through a mortar or through a small drug mill. Pass it then through a No. 60 sieve and grind again the remainder on the sieve until all passes entirely through. This point is very important, as the particles which resist the pestle frequently have a composition different from those which are broken up at first.

When the products for analysis contain organic materials, such as horn, meat, dried blood, &c., the grinding is often long and difficult, and produces a certain degree of heat which drives off the moisture in such a way that the pulverised product is finally drier and consequently richer than the original sample. It is important to note this desiccation, and as the pulverisation of a mass is not done without loss, the determination of the total weight of the sample before and after crushing does not give exact results.

It is, therefore, indispensable in this case to determine the moisture before and after the pulverisation and to restore by calculations the analytical results obtained in the pulverised samples to that which they would have had in the moist state of the original sample.

To avoid this necessity, as well as those difficulties which would thus result, owing to variations in the moisture during transportation, several chemists have thought that the best method of procedure would be to always dry the commercial product before submitting it to analysis, and to give in their reports their value in the dry state accompanied by the determinations of moisture, thus leaving to those interested the trouble of calculating the contents in the normal state, that is to say, the real state in which the merchandise is sold.

In addition to the fact that this method gives rise to numerous chances of error, much of the material undergoes important changes in composition by the mere fact of its drying. It has occasioned, in consequence, the worst frauds.

The retail dealers put these products on sale with a guarantee of their dry state, and a large number of farmers do not perceive the fraud which is hidden under this very innocent expression.

In this way guano containing 25 per cent of water has been placed on sale as having 12 per cent of phosphoric acid, when in reality it had only 8 per cent.

Having thus secured as fair a sample as possible, it is recommended, inasmuch as the uranium method is to be used in the determination, to ignite it in order to destroy organic matter. In respect of the method of doing this the French chemists are silent, and it appears from this, as well as many other parts of the report, that they have not studied the publications of our society as carefully as they ought to have done.

The solution of the phosphate is a matter, however, to which they have given much attention, and on this point they make many valuable suggestions.

Solution of the Material.

All phosphates, with the exception of certain aluminum phosphates (amblygonite, for example), easily dissolve in nitric and hydrochloric acids, more or less dilute, especially at the boiling point. But the best solvent of calcium phosphates is, undoubtedly, hydrochloric acid, which also dissolves iron and aluminum phosphates which are often found in phosphate of lime.

Nitric Acid.

In many laboratories nitric acid is preferred, to avoid, as much as possible, the solution of the sesquioxide of iron, which interferes with the determination of phosphoric acid in certain methods of analysis.

Since this is not the case with the citro uranic method, it is preferable to employ hydrochloric acid, because it completely dissolves the iron, and thus permits one to judge of the completeness of the analysis by the perfect whiteness of the remainder.

Pyritical Phosphates.

Certain phosphates, as those of the Ardennes and of the Meuse, contain iron pyrites which hydrochloric acid does not dissolve, and consequently leaves a remainder more or less discoloured. It is thus necessary to add nitric acid in the beaker where the analysis is being made, and prolong the boiling until the pyrites has disappeared, otherwise it will retain a small quantity of phosphoric acid in the state of ferric phosphate.

Sulphuric Acid.

In Germany many chemists make the analysis of phosphates with dilute sulphuric acid. This method, which certainly gives good results for certain products, presents numerous objections which unfit it for general use. The calcium sulphate which is formed requires prolonged washing, which gives rise to many chances of error.

In the case of aluminum phosphate, containing little or no lime, sulphuric acid may be preferable to hydrochloric and nitric acids, for it attacks amblygonite, which resists the first two acids.

But one seldom meets with such a case, and can always make use of the general method by first fusing the material with the classic mixture of standard carbonate of soda and carbonate of potassium (containing, of course, no phosphate).

In the great majority of cases the solution with hydrochloric acid is made very easily by simply boiling in a beaker, and without affecting the separation of the silica.

This operation is only necessary after the use of alkaline carbonates, or for those substances which contain decomposed silica giving gelatinous silica during the action of the hydrochloric acid.

There are two ways of making the solutions of the sample, which weighs from 1 to 5, or even 10 grms., depending upon the apparent character of the material to be analysed.

Solution by Filtration and Washing.—One can work by the ordinary method, consisting of making the solution, filtering, washing the residue on the filter, and mixing the liquids, and making up to a definite volume, and then taking an aliquot part for precipitation.

This method is long, and occasions numerous errors when the insoluble remainder is somewhat voluminous and contains some silica, which fills up the pores of the paper and renders the filtration difficult.

Test for Arsenic Acid.—When the sample examined is pyritical it often contains arsenic.

Since this is acted on by nitric acid, it can produce arsenic acid. This behaves in all cases as phosphoric acid, and if it is found in the sample it will be precipitated and estimated with the phosphoric acid. It is sufficient, in order to avoid this cause of error, to pass first through the solution a current of sulphurous acid, to carry it then to the boiling-point to get rid of the acid, and finally to pass through it a current of hydrogen sulphide, which precipitates the arsenic. Immediately after filtration the series of operations described can be repeated.

Volumetric Solution.—We advise the substitution of volumetric solution for solution by filtration and washing. This consists in acting on the sample with the acid in a graduated flask, and completing the volume with distilled water. After cooling, filter without washing, and take, by means of a pipette, an aliquot part of the total volume to make the precipitation. Thus the delays and the chances of error of washing upon the filter are avoided. It is true that this method leads to a certain error, due to the volume of the insoluble material which is left; but, as this quantity of insoluble material is generally very small, and as it is always possible to diminish it by increasing the volume of the solution, this cause of error is much less to be feared than those which may be produced in the other method without the knowledge of the operator.

In this last recommendation we have almost the exact method recommended by our former Committees. Some objections have been urged against the method on account of the error due to insoluble matter; but this error, in the very nature of the case, is so small as to be negligible when compared with the errors and complexity of manipulation to which any other method of solution is liable.

The French chemists, while admitting the perfect accuracy of the phospho-molybdate method of estimating phosphoric acid, recommend solely the volumetric method first proposed by Joulie. The preliminary precipitation of the ammonio-magnesium phosphate is conducted as follows:—

A quantity of the solution representing about 0·25 grm. of the sample, or at most 1·0 grm., if the sample be poor in P_2O_5, is taken. The total quantity of P_2O_5 in the sample taken should be about 50 m.grms. Then 10 c.c. of the citro-magnesian solution is added, and a large excess of ammonia. If the proper quantity of citro-magnesian solution has been used, the liquid will now remain perfectly clear.

The citro-magnesian solution should be prepared according to the following formula:—

	Grms.
Citric acid	400
Carbonate of magnesia (C. P.)	40
Caustic magnesia	20
Distilled water	500

After solution, enough ammonia (about 600 c.c.) is added to make the solution strongly alkaline, and the volume is then made up to 1500 c.c. If turbid the whole is to be filtered. After the magnesian phosphate is precipitated it should be allowed to stand at rest for some time (two hours) under cover, to avoid the evaporation of the ammonia. The filtration is made as carefully as possible, washing the precipitate with water containing one-tenth ammonia, and not bringing the precipitate on to the filter until near the last. The washing is continued (after all the precipitate is on the filter) until no precipitate is produced by phosphate of soda on the filtrate. The quantity of wash-water should be as small as possible. The phosphate is next dissolved in one-tenth pure nitric acid. The beaker in which the precipitation was made should be rinsed with this acid. The filter-paper should finally be put into the flask receiving the solution. All having been collected in a 150 c.c. flask, marked also at 75 c.c., one tenth ammonia is added until a slight permanent precipitate is formed. Two drops of one-tenth nitric acid are then added, and the flask placed on a sand-bath and raised to the boiling-point. Five c.c. acid acetate soda solution are then added, to neutralise the free nitrate acid. The acid acetate of soda solution is made as follows:—

	Grms.
Crystallised acetate of soda	100
Strongest acetic acid (glacial)	50
Distilled water, q. s., to make .. c.c.	1000

The solution of uranium is prepared according to the following formula:—

	Grms.
Pure nitrate of uranium	40
Distilled water .. .. c.c.	800

Dissolve and add ammonia until a slight cloudiness is produced, and then acetic acid to clear the liquid. The volume is then made up to 1000 c.c. with distilled water.

To obtain perfectly pure uranium nitrate the commercial salt is treated as follows:—

The nitrate of uranium often contains phosphate of uranium and ferric nitrate. It is necessary to get rid of the foreign products.

The commercial salt is to be dissolved and precipitated with carbonate of soda, which re-dissolves the oxide of uranium and precipitates the phosphate and oxide of iron.

Saturate the filtered liquor with nitric acid, and re-precipitate the oxide of uranium with ammonia. Wash it with distilled water by decantation, re-dissolve it in nitric acid, as exactly as possible, evaporate, and crystallise.

The crystals are taken up by ether, which often leaves a little insoluble residue. Filter and evaporate the ether. The remaining salt is perfectly pure.

The uranium solution prepared as above is much more sensitive than that prepared with the acetate of uranium, as recommended by Neubauer, and this acetate solution should never be used.

The phosphate solution for determining the strength of the uranium solution is prepared from pure acid phosphate of ammonium, a salt which is easily procured. This acid phosphate contains 61·74 per cent P_2O_5; 8·1 grms. pure dry acid ammonium phosphate dissolved to 1000 c.c. corresponds to 0·005 P_2O_5 in 1 c.c.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

UNIVERSITY COLLEGE, LONDON.

Chemical and Physical Society.

Ordinary Meeting, Thursday, October 21st, 1886.

"*An Improved Form of Weight Burette.*" By Mr. G. N. Huntly.

The apparatus consists of an ordinary burette into the neck of which is ground a glass stopper joined on to a capillary tube, in which is blown a small bulb about half an inch from the stopper. The burette is filled up to a mark on the capillary tube just below the bulb. It is then used in the ordinary way, and then filled up to the mark from a weighed quantity of the solution. By this means results correct to 0·001 c.c. can be obtained.

The apparatus is especially useful where it is necessary to add a known excess of a solution and then titrate backwards. N/1 solution can be added and titrated back with N/100 with great accuracy.

In standardising the solution the result must be expressed as parts in 1 grm., not, as is usual, in 1 c.c.

When it is desired to use this as an ordinary burette the attachment acts as a stopper, and in the case of solutions of stannous chloride, cuprous chloride, &c., where contact with the air is prejudicial, an absorption tube can be fitted to the end of the capillary tube.

CORRESPONDENCE.

WATTS'S DICTIONARY.

To the Editor of the Chemical News.

SIR,—There is, in the paragraph on "Castor Oil," in the Second Supplement to Watt's "Dictionary of Chemistry," p. 270, a mistake so singular that it seems worth correcting, especially as it has been transferred, with the paragraph, to a recent work on Oils.

In the place mentioned a statement is made about "Italian and Ostend castor oil:" now, without referring to the original statement of Popp in the *Archiv der Pharmacie*, one may be sure that "Ostindisch" (or the contraction Ostind.) was the word used; and that East Indian, and not Ostend, castor oil is intended.—I am, &c.,

W. H. DEERING.

Chemical Department, Royal Arsenal, Woolwich, October 23, 1886.

FLAME SPECTRA.

To the Editor of the Chemical News.

SIR,—Noticing a letter from Mr. G. G. M. Fielding in the last issue of the CHEMICAL NEWS (vol. liv., p. 212), referring to the difficulty of obtaining a continuous spectrum by means of the Bunsen flame, I have long since discarded the Bunsen burner for this purpose, and have used for some years past a jet of *pure* hydrogen from a No. 3 blowpipe jet, giving a flame about 1½ inches long and ⅝ inch in diameter in its broadest part. The substance to be examined is introduced on a platinum wire in the usual manner, with or without treatment with HCl, &c., as occasion requires. The hydrogen is generated from an ordinary lead apparatus on the displacement principle, and is at all times ready for work. A good supply of zinc (free from arsenic and antimony) is placed on a suitable tray in the gasometer, and the H_2SO_4 renewed about once a week.

I have found the above method gives a continuous spectrum and satisfactory results for all ordinary purposes. When a greater heat is required oxygen is introduced under pressure and the mixed gases burnt.—I am, &c.,

G. A. MILNE, F.C.S.

Malton, October 25, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. ciii., No. 15, October 11, 1886.

Purification of Yttria.—Lecoq de Boisbaudran.—Taking as his starting point an earth differing very little from that of M. Cleve, he submitted it to 32 fractionations with ammonia. The last precipitate was then subjected to 26 fractionations with oxalic acid. The last products thus obtained yield, after ignition, a very white earth; the spectrum of its sulphate no longer shows, in an appreciable manner, the red, green, blue and violet bands of the spectrum described by Mr. Crookes. The lemon band of *Za* alone is still visible, though faint.

Fluorescense of the Compounds of Bismuth exposed to the Electric Effluve in a Vacuum.—Lecoq de Boisbaudran.—Bismuth sulphate, previously heated to dull redness, does not fluoresce in a vacuum. A very small quantity of bismuth sulphate communicates to calcium sulphate the property of emitting a very fine fluorescence of an orange red. Bismuthiferous calcium carbonate yields only a violet fluorescence, differing little from that produced without the bismuth. With bismuthiferous strontium sulphate the fluorescence is still more brilliant than with the calcium salt, and inclines to an orange. Bismuthiferous barium sulphate gives a very fine fluorescence of a red less inclining to orange than that obtained with the calcium salt. Bismuthiferous magnesium sulphate fluoresces with a still more purely red light.

Reciprocal Relations of the Great Agents of Nature.—E. Schwœrer.—A notice of Prof. Klein's comments on the Inaugural Address of Prof Clausius as *Rector Magnificus* of the University of Bonn, and on M. Hirn's recent work, "The Notion of Force." Clausius explained the difference between the ideas anciently held in physics concerning the agencies of nature, such as heat, electricity, and light, &., and those which are now substituted for them. Without ignoring the connection between these agencies he shows the impropriety of such expressions as "transformation of heat into electricity and of electricity into light." The propagation of radiant heat and light may very probably be explained by an action of electric forces, and that very probably electricity itself may be substituted for the *ether* supposed to fill and pervade both space and all bodies. Prof. Clausius suggests that besides ponderable matter, there exists only one substance, and that the totality of phenomena may find their explanation by means of the varied movements of this substance. Prof. Klein thinks that M. Hirn has taken a further step by considering "force" taken in general as a class of elements specifically distinct from so-called ponderable matter, establishing that the ancient imponderables of physics, electricity, heat, &c., are not particular species of matter or vehicles of force, but forces properly so-called forming a class in common with the cause of gravitation.

Saturation of Normal Arsenic Acid with Lime-Water and Strontia Water.—Ch. Blarez.—Arsenic acid and lime water form six successive stages of saturation. Baryta water behaves in a different manner, which the author is engaged in examining.

Contribution to the Study of the Alkaloids.—Oechsner de Coninck.—The author has recently shown (*Comptes Rendus*, June 21 and July 5, 1886) that the iodomethylates, iodoethylates, &c., of the pyridic alkaloids give rise, in presence of potassa, to very sensitive coloured reactions. If we prepare piperidin iodomethylate (which is known to be a pyridin hexahydride) and treat it as has been done for the pyridin iodomethylate, no coloured reaction is produced. This is a very simple method for distinguishing a pyridic alkaloid from its hexahydride, and we may, without doubt, establish a difference of the same kind between cicutine and the corresponding collidine (conyrine). The same reaction enables us to distinguish the pyridic alkaloids from their aromatic isomers. Another reaction differentiates the pyridic alkaloids and their hexahydrides on the one hand and their aromatic isomers on the other. If we add to the iodomethylate of a pyridic alkaloid some fragments of potassium hydroxide, then water enough to form a pasty mass, which is then heated, a characteristic odour is developed, due to the formation of pyridic dihydrides. If the iodomethylates of piperidine, cicutine, aniline, orthotoluidine, metaxylidine, &c., are

treated in a similar manner, this characteristic odour is not produced.

Journal de Pharmacie et de Chimie.
Vol. xiv., No. 5, September 1, 1886.

The Presence of Lecithine in Plants.—E. Haeckel and F. Schlagdenhauffen.—Already noticed.

On Cows' Milk, Normal and Pathological; Analysis, Watering, Albumenoid Matters.—Henri Lajoux.—The author complains of the tendency of chemists to take "total solids" as the standard of the purity of milk. He proposes, instead, the total albumenoid matters. He uses in his analyses that archaic instrument the lactodensimeter: he determines total fixed matters by evaporation at 95°; saline matter by incineration; milk-sugar by means of Laurent's polarimeter, after clarification by means of lead acetate; butter by extraction with ether, after desiccation along with sand, and albumenoids by difference.

Analysis of the Liquid of a Cyst.—P. Macquaire.—The liquid contained paraglobuline, fibrinogen, albumen coagulable by heat, and albumen coagulable by nitric acid only.

On Simple Processes for Detecting Silver, Nickel, and Tin deposited in Thin Layers on Metallic Objects.—L. Lonton.—Already noticed.

Justus Liebig's Annalen der Chemie,
Vol. ccxxv., Part 3.

Communications from the Chemical Institute of the University of Bonn.—These consist of memoirs on the behaviour of certain diazo- and diazo-amido-compounds, by O. Wallach; and on a method for easily obtaining organic fluorine-compounds, by the same author.

The Action of Bromine and Water on the α-Meta-isocymol-sulph Acid, and on the Constitution of the α and β Meta-isocymol-sulph Acids.—Kelbe Werner and Czarnomski.—This investigation shows that in meta-isocymol only two atoms of hydrogen, and always the same, can be replaced by the sulpho-group, or by bromine if the sulpho-group has been already introduced. On dissolving meta-isocymol in sulphuric acid the sulpho-group enters in place of the hydrogen atom 4 or 6. If bromine acts upon the α-cymol-sulph acid (SO_3H being in 6) it is substituted for the hydrogen atom 4; if it acts upon β-cymol-sulph acid (SO_3H in 4) it is substituted for the H atom 6. If α-bromcymol (Br in 6) is dissolved in sulphuric acid, the sulpho-group is substituted for the H atom 4. If, on the other hand, β-bromcymol (Br in 4) is dissolved in sulphuric acid, the H atom 6 is replaced by the sulpho-group.

Action of Aluminium Chloride.—R. Anschütz.—A continuation of the extensive memoir commenced in the previous number.

The Combinations of Nitrogen with Gold.—F. Raschig.—All the three oxides of gold, Au_2O, AuO, and Au_2O_3, yield explosive compounds with ammonia. That of the monoxide has been obtained by the author for the first time. For this compound he proposes the name sesquihydraurylamine, and for the body extracted from it by boiling water the name trihydraurylamine.

The Iodalkylates of Sparteine.—E. Bamberger.—The author has obtained a mono-iodhydrate of sparteine, the compound previously described by Mills being sparteine-iodethylate hydriodate.

Biedermann's Central Blatt fur Agrikultur Chemie.
Vol. xv., Part 6.

Formation of Saltpetre Earths in the Tropics.—A. Muntz and V. Marcano.—From the *Comptes Rendus.*

Difference of Temperature between Town and Country.—J. Hann.—The author has obtained comparative observations for Vienna, Budapest, Cilli, Linz, Munich, Perpignan, St. Louis (Missouri), and Calcutta. From these data it appears that the yearly mean temperature in a town is, with rare exceptions, higher than in the adjoining country. This excess varies from ½° to 1°, and seems to depend less on the size of the town than on the surroundings of the station for observation. Both the daily and the absolute fluctuations are smaller in towns than in the open country.

The Oxidation of Ammonia in Waters and Soils.—J. Uffelmann.—The author proves that the oxidation of ammonia can take place without the co-operation of microbia, at least in cases of strong surface attraction. Experiments with spring-water and with the water of the Rostock town supply, showed that even in water not free from germs, and in vessels not sterilised, the oxidation of ammonia takes place much more slowly than it is commonly assumed.

Influence of Gypsum upon the Formation of Saltpetre.—R. Warington.—Evidently from an English source.

Experiments on the Cultivation of Barley.—Dr. Rehm.—Not suitable for abstraction.

The Nutritive Value of Certain Products of the Digestion of Albumen, and on the Value of the So-called Meat Peptones.—S. Pollitzer and Prof. M. Zuntz.—Peptones and the hemi-albuminoses have about the same nutritive value as meat, and the assimilation of nitrogen which ensues on their ingestion forms a striking contrast to the loss of nitrogen which ensues on a diet containing an equivalent proportion of gelatin. The peptones of commerce, not prepared by the action of gastric juice but by the action of superheated water, have the same nutritive value as meat.

MISCELLANEOUS.

Franklin Institute.—We have received from the Secretary of the Franklin Institute of the State of Pennsylvania the Announcement and Programme of Lectures at that Institute for 1886 87. The Course of Lectures comprises the subjects of Chemistry, Electricity, Mechanics, Metaphysics, and the Arts and Manufactures, and we note as a sign of the times that two Lectures on Chemistry applied to Plant Life are to be delivered by Miss Helen Abbott. The Programme is very neatly got up, and managers of similar institutions in England would do well to follow such a good example.

Non-Acid Components of Bees'-Wax.—Fr. Schwalb.—Bees'-wax, in addition to the higher fatty acids and alcohols, contains two hydrocarbons, two of which, having the melting-points 60·5° and 68°, have been isolated by the author, and are probably identical with Krafft's normal heptacosan and hentriacontan. The alcohol of wax having the highest melting-point, to which Brodie ascribes the formula $C_{30}H_{62}O$, is more probably $C_{31}H_{64}O$, whilst Brodie's formula seems to suit the alcohol of carnauba wax. In addition to myricylalcohol there exists in bees'-wax ceryl alcohol and a third alcohol, $C_{24}H_{50}O$.—*Liebig's Annalen.*

MEETINGS FOR THE WEEK.

MONDAY, Nov. 1st.—Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "What shall we do with our Tar?" by Mr. L. T. Wright, C.E.

THURSDAY, 4th.—Chemical, 8. "Researches on the Laws of Substitution in the Naphthalene Series—No. II.," by Dr. H. E. Armstrong, W. P. Wynne, B.Sc., and S. Williamson. "The Hydrolysis of Sulphonic Acids" and "The Action of Bromine on Toluene-Parasulphonic Acid," by Dr. A. K. Miller.

THE CHEMICAL NEWS.

Vol. LIV. No. 1406.

THE PRESERVATION OF GASES OVER MERCURY.*

By HAROLD B. DIXON, M.A., F.R.S.

Can gases be preserved for any considerable time over dry mercury? Faraday has told us that it is impossible; Sir Humphry Davy has maintained the contrary.

When I began experimenting with gases, ten years ago, I was under the influence of Faraday's teaching, confirmed, as it seemed to be, by the readiness with which a gas, enclosed in a vessel over mercury, will find its way along a platinum wire bent so as to connect it, through the mercury, with the outer air. At first I hesitated before using any gas which had been collected a few weeks previously; but, as analysis showed no alteration in the gases, I concluded that the ordinary process of inter-diffusion must be slower than that found by Faraday. As weeks lengthened into months, and still no alteration could be detected in the tubes, I became sceptical of any diffusion taking place, and after a couple of years I became convinced that if any diffusion took place at all, it was too slow to sensibly affect the results of an analysis made with a sample of gas collected within twelve months.

In Dr. Bence Jones's "Life of Faraday" a passage occurs which shows that Sir Humphry Davy did not accept Faraday's results. In 1823 Faraday had filled five dry bottles over mercury with a mixture of oxygen and hydrogen. These bottles had been examined in the following year, and a considerable alteration had been detected in the confined gas. From this experiment Faraday concluded "that mercury cannot confine gases perfectly." Davy, dissatisfied with the conclusion, repeated the experiment. The last entry in the Laboratory note-book of the Royal Institution, written by Sir Humphry Davy's hand, is dated February 5, 1826:—

"Experiment of July, 1825, examined. The hydrogen, confined by mercury, whether in a bottle with a stopper, or merely confined by dry mercury, contained no common air."

Faraday also repeated his experiment. On June 28th, 1825, he partially filled three vessels with a dry mixture of oxygen and hydrogen over the mercurial trough. The vessels were 3-ounce glass bottles with well-fitting ground stoppers, well cleaned and dried. No grease was on the stoppers. The bottles were filled four-fifths full of the mixed gases, the rest of the space being occupied by the mercury. The stoppers were then replaced "as tightly as could be," the bottles put into glasses in an inverted position, and mercury poured round the stoppers and necks, rising not quite up to the level of the mercury within. The bottles were then "sealed up" in a dark cupboard.

On September 25th, 1826, after fifteen months, the bottles were opened and examined. The mercury still remained higher inside than outside.

I. Part of the contents transferred in the mercury trough proved to be common air. No trace of the original mixture remained.

II. The mixture was still explosive. Spongy platinum was brought to dull ignition in it: no explosion took place, but the volume diminished to rather less than one-half. The residue supported combustion little better than common air. Hence nearly half the mixture had escaped.

III. The mixture was explosive. It contained nearly two-fifths of a mixture of oxygen and hydrogen, the rest being very little better than common air.

Faraday concludes there is "no reason to suppose that this capability of escape between glass and mercury is confined to the mixture of hydrogen and oxygen. Probably every gas having no action on mercury or glass would have made its way out in the same manner."*

Apart from the interest naturally attaching to a point in dispute between two such masters of their craft as Davy and Faraday, the settlement of this question is of some importance to all chemists who work with gases. After reading the passages referred to in the "Life of Faraday," it occurred to me that I might have the data for deciding between the two conclusions, for I had kept the unused residues of several samples of different gases which had been prepared at various times since 1876. An analysis of these gases would show whether any appreciable diffusion had gone on between the contents of the tubes and the outer air, and the long period for which some of the samples had been kept afforded the condition of time necessary to give accuracy to the results. If it should be found that gases had remained over mercury not appreciably altered for periods up to ten years, it seemed to me that the question might be answered unhesitatingly in Davy's favour; but if Faraday's view were correct, the analyses would not only show this, but would afford some idea of the average rate of the slow gaseous diffusion between the mercury and the glass.

I resolved therefore to analyse all the samples of gas I had remaining which had been kept for periods longer than two years. On examining my cupboards I found the following samples;—

Two tubes, electrolytic gas, prepared Jan., 1877.
Two tubes, cyanogen, prepared Aug., 1878.
One tube, sulphurous acid, prepared Feb., 1880.

I was disappointed at finding no other samples prepared by myself of over two years' standing; the hydrogen, carbonic oxide, and oxygen tubes had been used and replenished within the last two years. But a search through other cupboards in the laboratory revealed a stand of five tubes filled with hydrogen, bearing the date May, 1884. These tubes had evidently been filled by one of my pupils in a class for gas analysis which I held during that month. There was no name attached, and I cannot recall the handwriting on the label. The contents of these hydrogen tubes were first determined by exploding them with excess of oxygen. The numbers attached to the analyses give the order in which the tubes had been originally filled with the gas, which was prepared by the electrolysis of dilute hydrogen sulphate:—

	1.	2.	3.	4.	5.
Percentage of hydrogen ..	93·6	96·0	97·3	99·4	99·7

These analyses are not conclusive as to the preservation of the gas intact over mercury, but, looking to the regular increase in the percentage of hydrogen found, I think the most probable interpretation of the numbers is that the collection of the gas was begun before all the air had been swept out of the apparatus, and that the gases were found in the tubes in the same condition as when they were collected two years and three months previously.

The sulphurous acid collected in 1880 was next examined. The gas was almost completely absorbed by solution of potash, the contraction being 99·4 per cent.

The two samples of cyanogen collected in 1878 were exploded with excess of oxygen, and the carbonic acid formed was absorbed by solution of potash. The first sample showed a slight contraction on explosion, and the volume of gas absorbed by the potash, calculated as carbonic acid, gave 100·68 per cent of cyanogen. The second sample showed no alteration of volume on explosion, and the volume of gas absorbed by potash, calcu-

* A Paper read before the British Association, Birmingham Meeting, Section B.

* *Quart. Journ. Science*, xxii., 220.

lated as carbonic acid, gave 99·79 per cent of cyanogen. These numbers agree with the results of several analyses I have made with freshly prepared cyanogen, a small quantity of nitrogen—varying in amount with the excess of oxygen used—being oxidised in the explosion.

The two samples of electrolytic gas, prepared in January, 1877, were found on explosion to contain 98·95 and 98·86 per cent of explosive gas. A sample of electrolytic gas, prepared a month ago with the same apparatus, was found to contain 98·91 per cent of explosive gas.

The analyses of these five samples of gas, collected 6½, 8, and 9½ years ago, are sufficient to show that gases may be preserved over mercury without suffering in any appreciable degree from diffusion. If diffusion had taken place at all in these cases, it was too small to be detected by careful analysis after several years; so that we seem forced to conclude that diffusion, in the sense used by Faraday, does not take place between mercury and glass under the conditions of these experiments.

Everyone will agree that Faraday's manipulative skill precludes all idea of any accidental contamination of the gases he used; everyone will agree that the results he found are the true expression of the facts of the case before him. The question therefore arises—How do the conditions of his experiments differ from those of mine? In my experiments the gases were collected in *hot* tubes filled with *hot* mercury. The mercury in the trough was kept from 70° to 90° C. Each tube was brought hot from the oven as it was required; a card, cut to fit the trough, was drawn through the mercury, leaving behind it a brilliant clear surface of the liquid. Into the surface so cleared the open end of the tube was plunged. The tube was then depressed into the mercury, and filled by inversion below the surface, a leathern glove protecting the operator's hand. The tube, still containing a few small bubbles of air, was then filled with the gas, and was again charged with mercury by depressing it under the liquid. After being filled a second time with the gas, the end of the tube was passed into a small crucible which had been heated before being introduced into the mercury. The tube and crucible were then removed from the trough to a wooden stand.

Faraday makes no mention of his having heated his mercury and glass vessels, so that it is probable that the glass may have had a slight coating of moisture upon it, and it is possible that the mercury may have had a fine film of impurity on its surface. Such a film sticking to the glass, whether of moisture or of impurity on the metal, may have made the means of communication between the enclosed gases and the air outside.

Post Scriptum.—Since reading this paper I have repeated an interesting experiment described to me by Prof. McLeod. It throws light on the action of a film formed between glass and mercury. Air is drawn through a U-tube filled at the bend with pure mercury. The air passes through the liquid in large bubbles, throwing the mercury up the tube and breaking it into globules. A thin strip of clean sheet lead is now dropped into the mercury. In a minute or two the bubbles of air diminish in size, and the column of mercury is less disturbed. After about ten minutes the air passes in a continuous stream between the glass and mercury, and with so little commotion that the passage of the air would be almost invisible but for the quivering vibration on the surface of the liquid. An unbroken passage is formed between the glass and the impure surface of the mercury.

By reference to Faraday's "Chemical Manipulation" (New Edition, 1830) I find that Faraday was aware in 1830 of the action of the films on impure mercury. In par. 1279 he writes:—

"The manner in which these films interfere with experiments made over the mercurial trough is principally by preventing contact between the metal and the jars used. If a jar be dipped into the mercury, it does not break through the film and come into contact with the pure metal beneath, but the film expands between the glass and the metal, and, from its comparatively solid and rigid nature, entirely prevents that close contact which would occur between pure mercury and the glass."

In the discussion which followed the paper Mr. Crookes and Sir Henry Roscoe gave it as their opinion that the purity of the mercury was the essential condition for preventing diffusion, which depended on the formation of a film between the mercury and the glass.

Mr. Turner said that the experience of Dr. Frankland confirmed the opinion of Mr. Crookes and Sir H. Roscoe, that diffusion did or did not take place according to the state of the mercury and of the containing vessel.

Mr. A. G. Vernon Harcourt said that it might have been supposed that dirty mercury, from its known property of adhering to glass, would have been most efficient in preventing diffusion. This, however, did not appear to be the case, and he suggested that some comparative experiments should be made with pure and with dirty mercury.

Dr. Gladstone said that when talking on this subject some years ago to a friend, he was answered that, if gas could not be retained without diffusion, then we could have no mercurial barometer.

Prof. H. McLeod pointed out that dirty mercury, though it appeared to adhere closely to glass, did not really do so, but allowed a passage between the film and the glass surface. The standard barometer at Kew had been prepared with hot mercury, and though constructed many years ago it was believed to be perfectly accurate.

Dr. S. Young said that his experience with barometers, which was considerable, showed that some barometers remained perfectly correct, while others did not.

ON THE

DISTRIBUTION OF THE NITRIFYINC ORGANISM IN THE SOIL.

By R. WARINGTON.

Previous experiments, conducted at Rothamsted on this subject (*Trans. Chem. Soc.*, 1884, p. 645), had led to the conclusion that the nitrifying organism is always to be met with down to 9 inches from the surface, and that at 18 inches it is sometimes present; but experiments with soil 2 to 8 feet from the surface failed to yield evidence of the presence of the organism.

Further experiments have been made in 1885, and during the present year, both in the field with the stiff clay subsoil previously worked on and in another field having a loamy subsoil; in all sixty-nine new experiments have been made. The soil in the previous experiments was removed, with suitable precautions, from a freshly cut surface, and placed in sterilised solutions consisting of diluted urine (0·4 per cent). It having since been found that the facility with which urine nitrifies is greatly increased by the presence of gypsum (*Trans. Chem. Soc.*, 1885, p. 758), an addition of a small quantity of gypsum was made to the solutions employed in all the recent experiments; rather larger quantities of soil were also employed. The results may be summarised as follows:—

Depth of soil.	Number of expts.	Number of solutions nitrifying.	Number nitrifying out of 10 trials.
Less than 2 feet	17	17	10·0
2 feet	11	11	10·0
3 ,,	11	10	9·1
4 ,,	11	7	6·4
5 ,,	2	1	5·0
6 ,,	9	4	4·4
7 ,,	2	0	0·0
8 ,,	6	0	0·0

* Read before the British Association, Birmingham Meeting, Section B.

Six of the above experiments were made with chalk, which underlies the Rothamsted subsoil; the chalk was from depths of 5, 6, 7, and 8 feet. None of the samples of chalk produced nitrification.

The new results show a far deeper distribution of the nitrifying organism than was concluded from the earlier experiments. The power of producing nitrification is now found to exist generally down to 3 feet from the surface. Below this point the occurrence of the organism becomes less frequent, though at 5 and 6 feet about half the trials resulted in nitrification. With soil from 7 and 8 feet no nitrification was obtained. The considerable difference between the earlier and later results is to be attributed to the employment of gypsum in the later solutions. The nitrifying organism in the subsoil is indeed less abundant, and probably much more feeble than in the surface soil, and is apparently unable to start nitrification in the decidedly alkaline solution which urine produces in the absence of gypsum.

Although it appears that the nitrifying organism may exist at considerable depths, nitrification is practically confined to the surface soil. The quantity of nitrogen as nitric acid annually obtained in the drainage water from soils of different depths in the drain gauges at Rothamsted is on an average of nine years:—

Soil 20 inches deep	..	..	..	40·2 lbs.	per	acre
Soil 40	,,	,,	..	..	..	35·0	,,	,,
Soil 60	,,	,,	..	..	..	38·8	,,	,,

There is no evidence here of a greater production of nitrates when the subsoil is included in the experiment.

Nitrates are always found most abundantly in the surface soil unless heavy rain has occurred to wash them downwards. Two fallow soils at Rothamsted were found to contain the following quantities of nitrogen as nitrates in lbs. per acre:—

1st 9 inches	..	..	..	..	28·5	40·1
2nd ,,	..	..	..	..	5·2	14·3
3rd ,,	..	..	..	..	—	5·5
Total	..	..			33·7	59·9

THE COLOUR OF THE OXIDES OF CERIUM AND ITS ATOMIC WEIGHT.*

By HENRY ROBINSON, M.A.,
Assistant to the Professor of Chemistry, in the University of Cambridge.

AT the Meeting of the British Association at Montreal I had the honour to submit to this Section a paper on the atomic weight of cerium. On that occasion I did not say anything about the colour of the oxides of cerium: Wolf had stated he had prepared a white oxide, and I thought it possible there might be an oxide of that colour. My subsequent experiments have not confirmed that opinion.

Before Wolf commenced his investigation it had been recognised that the brown colour of the mixed oxides obtained from cerite, or from other sources of cerium, was due to the presence of didymium, and it had been found that the more completely the didymium was removed from them the lighter became the colour of what was left. "Still at the best," quoting from Clarke's "Constants of Nature," "a faint colour remained which was supposed to be characteristic of the oxide itself. In 1868, however, some experiments of Dr. Wolf were posthumously made public, which went to show that pure ceroso-ceric"—or, as it is called now, ceric—"oxide is white, and that all samples previously studied were contaminated with some other earth, not necessarily didymium, but possibly a new substance, the removal of which tended to lower the apparent atomic weight of cerium very perceptibly." Further on he says "The last oxide was perfectly white," and again, at the end of the article on cerium, "It is now clear that new determinations are needed, made with a material yielding *white* ceric oxide." It seems to me that discrimination has not been made between that lighter colour which follows the gradual removal of didymium and that "faint colour supposed to be characteristic of the oxide itself."

When didymium is gradually removed the oxides decrease in colour from a dark brown to a faint reddish brown, which tinges the yellow ceric oxide when the least trace of didymium is present: the faint colour is a very pale sulphur-yellow, altogether free from brown or red.

It is probably owing to the great prominence given by Clarke to Wolf's work that the somewhat prevalent notion obtains that cerium has a white oxide; possibly the opinion that such is the case has been strengthened, or even begotten in some cases, by the fact that cerous salts with colourless acids are white. But it is by no means true that a coloured base with a colourless acid need give a coloured salt. To take two instances—cuprous oxide is red, cuprous chloride is pure white; silver oxide may be bluish, or brown, or black, according to the way in which it has been prepared, but its chloride, nitrate, and sulphate are white. I think that any inference that even cerous oxide is white because its salts are white may be dismissed without further consideration. Besides, when hydrogen is passed over heated ceric oxide, the oxide becomes darker in colour, dark grey or almost black, water being formed at the same time.

I will now return to Wolf's work, and I think I shall be able to show that some great mistakes have been made. In the first place, his mode of separation was an improper one, and would not result in the production of a pure cerium salt; secondly, his method of analysis would not give correct results, as Brauner has already proved by experiment; and thirdly, if the atomic weight of his metal was 137, or anything near that number, it was not an oxide of cerium at all. Wolf's mode of separation was as follows:—He first prepared, from Swedish cerite, basic cerium sulphate, by Bunsen's well-known method, mixed with a considerable quantity of didymium and lanthanum sulphates. He dissolved and re-precipitated it several times as basic sulphate, rejecting the mother-liquor. The method so far was good. Bunsen says if it is persevered in, in the end a very small quantity of pure basic sulphate of cerium may be obtained. He next dissolved the precipitate, which he says still contained a considerable quantity of didymium, and which, my own experience tells me, would also contain a good deal of lanthanum by adding a little sulphuric acid. He then reduced the ceric sulphate by sulphurous acid, and drove off the water and excess of acid by heat. His method from this point, although he made one or two slight deviations, was essentially as follows:—The mixed sulphates were dissolved in water, and fractionally crystallised many times by gently evaporating their solution on a water-bath; the mother-liquor was rejected each time. And here was the first mistake; he fell into an error similar to that a certain manure manufacturer is said to have done. It is related of the latter that, attending a lecture on agricultural chemistry, he heard there that ammonium sulphate might be economically prepared by mixing gypsum with the ammoniacal liquid from gas-works. He went to his works, and proceeded to utilise his newly-acquired knowledge; he mixed gypsum with the gas-liquor as directed, left it to stand for a time, and then, like Wolf, he too threw away his mother-liquor, and, after carefully drying the precipitated calcium carbonate and other worthless substances, sent it out to his unfortunate customers as a very superior sample of sulphate of ammonia. He succeeded in preparing the wrong thing entirely, and so did Wolf if his oxide was white and its metal had an atomic weight anywhere near 137. My contention is that fractional crystallisation of a mixture of cerium, lanthanum, and didymium

* A Paper read before the British Association, Birmingham Meeting, Section B.

sulphates will not give cerium sulphate as an end product, but lanthanum sulphate, or a mixture of the two. The didymium will be eliminated first, next the cerium, and the lanthanum will remain behind; and this explains why Wolf obtained a white oxide, and why his atomic weight was so low. I have made some experiments to prove this, following Wolf's plan. When he arrived at the cerous sulphate stage he says a good deal of didymium was still present. I am certain no small quantity of lanthanum was there also, although he says nothing about it; indeed his whole paper goes to show he never even suspected its presence. He dissolved the whole in water, and crystallised by evaporating the solution until but little of the mother-liquid remained. The mother-liquid gave a brown oxide, the crystals a brick-red one. The process was repeated five times. The resulting mass of crystals was then fractionated by slow evaporation on the water-bath into three portions, A^1, A^2, and A^3; then A^1 into B^1 and B^2; and, lastly, B^1 into C^1 and C^2. Of these fractions B^2, C^1, and C^2 were analysed. B^2 gave the atomic weight of cerium 138·312, C^1 138·528, and C^2 138·843. It will be seen from this the least soluble fraction of B^1 gave the lowest atomic weight.

I commenced my experiments so as to produce as nearly as possible Wolf's A^1 series of crystals. I took cerium oxalate nearly free from didymium and lanthanum, and lanthanum oxalate free from cerium but still containing a little didymium, and mixed them so that I should have four parts of Ce_2O_3 to one part of La_2O_3. The oxalates gave me 44 grms. of anhydrous sulphates, which were dissolved in 860 c.c. of water. The solution was almost colourless, but showed plainly the didymium absorption-bands.

Wolf says he evaporated slowly on the water-bath, but he does not say at what temperature. I took care in my experiments always to conduct the evaporations as nearly as possible at 65°. The first solution was evaporated until a fair quantity of crystals had formed; then the mother-liquor, 400 c.c., was quickly drawn off by a reverse filtering-cone; another crop of crystals, A^2, was taken from it, and then the remaining liquid, which would contain the A^3 crystals, was found to be plainly coloured by didymium, showing, as might be expected, that the bulk of it had accumulated here. The first crop of crystals, A^1, was dehydrated, and found to then weigh 18 grms. It was dissolved in 430 c.c. of water; the didymium absorption-bands showed, but weak. B^1 was crystallised out as before, and weighed 8 grms. It was dissolved in 200 c.c. of water; the didymium absorption-bands were now very weak. C^1 was crystallised from it, and weighed 3·5 grms. as anhydrous sulphate; the mother-liquor measured 122 c.c.

The C^1 fraction of crystals should now, according to my view, contain a good deal of lanthanum. In order to determine the quantity it was converted into oxalate, and then into oxide: the latter weighed 1·6368 grms.; it was yellow. The oxide was dissolved in nitric acid; the solution was evaporated on a sand-bath until fumes of nitric oxide had been given off for some time; the dry mass was then treated with hot water and a very little nitric acid, and the soluble portion was filtered from the insoluble. The filtrate was evaporated to dryness, and was treated exactly as the first dry mass had been: what was insoluble was added to the first portion of insoluble. The whole of the insoluble, after igniting, was boiled with nitric acid, again heated until nitric fumes came off, and the soluble was again extracted and added to that already obtained; and the process was repeated until, on the one hand, an insoluble portion was obtained from which nothing more could be dissolved, and, on the other, a soluble one from which nothing insoluble could be separated. The soluble part was now converted into oxide; it was white, slightly tinged with red by the very small quantity of didymium left in it, and weighed 0·527 grm. There was so little didymium in it that it might safely for the present purpose be considered all La_2O_3. To make sure it was dissolved in nitric acid the solution was perfectly colourless, and on testing with hydrogen peroxide and ammonium acetate only a mere trace of cerium was found to be present. Subtracting this 0·527 grm. from the oxide first obtained, 1·10975 grms. of ceric oxide is left, and reducing this to Ce_2O_3 1·05815, so that now the proportion of cerous oxide to lanthanum oxide is as 1·05815 to 0·527, or as 2 to 1, instead of as 4 to 1 at the commencement of the experiment.

I now thought it would be well to determine the relative solubilities of cerous and lanthanum sulphates in water at the temperature I had crystallised the mixture. I took 10·643 grms. of anhydrous cerous sulphate, dissolved it in 170 c.c. of water at the ordinary temperature,—it was about 20°,—evaporated the solution on the water-bath at from 60° to 65°. In this and the following experiment I took care that the ring on which the evaporating dish was placed was much smaller in diameter than the surface of the liquid in the dish, and also that the diameter of the evaporating dish was less than that of the water-bath: by this means I prevented a ring of sulphate forming where the surface of the liquid touched the side of the dish. Had this precaution been taken in the previous experiments I am persuaded the proportion of Ce_2O_3 to La_2O_3 would have been less even than it was. The solution was much reduced in volume before crystals began to appear. When a good quantity had formed I filtered the liquid through a dry filter placed in a funnel surrounded by a hot-water jacket into a 50 c.c. flask placed in water at 65°, the liquid remaining after the 50 c.c. was filled to the mark measured 17 c.c. The amount soluble in 100 c.c. of water at 65° was 10·2958 grms. of anhydrous sulphate.

I then made an exactly similar experiment with lanthanum sulphate. 6·306 grms. of the anhydrous sulphate were taken, and dissolved in 190 c.c. of water at about 20°. After standing about twenty-four hours some crystals had already formed. On evaporating the solution, tufts of crystals began to appear before its temperature reached 60°. After about the same quantity of crystals seemed to have formed as when the evaporation of the cerous sulphate was stopped, the liquid was filtered, everything being done as in the previous experiment, into the 50 c.c. flask, but the liquid remaining in this case, after filling the 50 c.c. flask, measured 80 c.c. 100 c.c. of water at 65° held in solution 2·106 grms. of La_23SO_4. So that the solubility of cerous sulphate at this temperature is nearly five times as great as that of lanthanum sulphate.

I think these experiments show pretty conclusively that Wolf's method was not one by which pure cerous sulphate could be obtained. Wolf's determination of the atomic weight of cerium is based entirely upon the amount of ceric oxide he obtained from what he supposed was the anhydrous sulphate. He dehydrated his crystals by heating them in a small platinum crucible placed in a larger one over a naked flame. Bührig has shown that this would not effect the desired end; that at a moderate temperature the water is not completely driven off; and that at a slightly higher one the salt is decomposed.

Brauner also found this to be the case. He says at 500° the salt may lose a trace of sulphuric acid, or it absorbs some oxygen and becomes heavier and slightly yellow. He overcame the difficulty by heating the salt in a sulphur-bath; at 440°, the temperature of boiling sulphur vapour, the dehydration was complete, and no decomposition of the sulphate could be detected. His method and apparatus are described in the *Transactions of the Chemical Society*, 1885. Thus the real composition of Wolf's anhydrous sulphate becomes very doubtful. He dissolved the anhydrous sulphate in water and precipitated the cerium as oxalate, and determined the amount present as CeO_2.

Wolf's number for the atomic weight of cerium depends entirely on the amount of ceric oxide thus obtained, for the sulphuric acid was not estimated; at any rate there is not a single scrap of evidence to show it was. One thing goes against my theory that this white oxide was La_2O_3

or a mixture of it and CeO_2, with a preponderance of the former. In Wolf's paper this passage occurs:—"The resulting ceroso-ceric oxide was always analysed, and the amount of cerous oxide corresponding with it determined according to Bunsen's volumetric method by iodide of potassium and chlorhydric acid from the amount of liberated iodine"; and this statement, for instance, is made "(1) 1·4542 grms. of B^2 gave 0·19419 grms. water and 0·763·05 grms. ceroso-ceric oxide, corresponding with 0·72443 grms. cerous oxide," but no details are given; nothing is said about what precautions were taken to ensure accuracy in measurements, or even how the information obtained was made use of. The analysis might be only qualitative, and the statement would still remain true. I have gone through the numbers, and have found that there are curiously constant errors for each different series, which lead me to suppose that the amounts of cerous oxide corresponding to the ceric oxide found were calculated; it matters little what equivalents are taken in doing so, for the differences for different equivalents are almost inappreciable. This phantom white oxide seems to have led men's minds astray. Wolf evidently felt bound to find a white oxide and a low atomic weight. What he considered his purest salt gave 136·992 as the atomic weight of cerium, but re-calculated by Clarke it became 138. Brauner says his *purest* oxide was white, but he preferred to call it the "palest chamois." The latter description would apply to my oxide, but I prefer to call it a pale sulphur yellow: his and my atomic weights were practically identical, being 140·2210 and 140·2593 respectively.

Mr. Crookes* has lately obtained a white ceric oxide, but, unlike Wolf's, his atomic weight is high, 141·1; whilst Bühring, whose atomic weight was also high, 141·228, had a yellow oxide.

The apparent colour depends much on the physical state of the oxide; an oxide decidedly yellow in a lumpy state becomes pale when finely powdered; but the preponderant opinion among observers is that, even in the finest powder, ceric oxide is not really white.

ON THE

PRODUCTION AND MEASUREMENT OF GOLD AND OTHER MINUTE METALLIC SPHERES TO DETERMINE THEIR WEIGHT.

By G. A. GOZDORF.

IN making assays for gold where the amount of gold is very small a little silver is required in which the gold may be collected. As nearly all commercial litharge contains silver it is rarely necessary to add any separately for this purpose. The litharge I at present use contains at the rate of 6 dwts. of silver and ¼ of a grain of gold per ton.

Having obtained a prill in which the amount of gold is a third or less than the silver, the prill is boiled in dilute nitric acid in a porcelain capsule to dissolve the silver, and where the amount of gold is more than 1 dwt. to the ton a second boiling in strong nitric acid should be given. If care is taken in using dilute acid at first and boiling gently the gold will be left in one piece of a nearly black colour. The acid is now decanted off and the gold washed two or three times in distilled water. The gold may be now placed on an aluminium or other polished metal plate by inverting the capsule and leading the last drop of water and the gold with a glass rod on to the plate, the water is drawn off by a piece of filter-paper, and the plate gently heated till dry.

Having thus obtained the gold in a pure state a bead is made of boracic acid on a platinum wire loop and pressed on the gold while still red-hot; the gold adheres without difficulty, and by heating the bead before the blowpipe the gold is obtained as an almost perfect sphere.

Should the resulting sphere of gold be very minute it is better to measure it under the microscope while in the bead, but if large enough to be seen with the naked eye it can be measured more accurately after dissolving the boracic acid bead in a watch-glass with hot water and placing the sphere of gold on a glass slide.

The plan of measuring minute prills of silver and gold to determine their weight was first introduced by Harkort, wo used an ivory scale engraved with two fine lines meeting at an acute angle and divided into fifty equal parts.

According to the fifth edition of Plattner's "Probirkünst," p. 520, Goldschmidt determines the weight of silver and gold prills by measurement with the microscope. As I have not access to the paper on the subject his manner of preparing the prills for measurement is unknown to me.

Harkort and Plattner, in making scales for the determination of the weight of gold and silver prills, weighed prills corresponding to the larger divisions of the scale, and from their weight calculated the weight for the smaller divisions. These prills were taken direct from the cupel, and at the point of contact are flattened, but as the amount of flattening is not always the same, and hardly varies in extent with the size of the prill, and as the converging lines on the scale cannot be very sharply defined, this method is not capable of the same accuracy as where the almost perfect spheres are measured with a microscope.

No other flux seems to possess advantages equal to those of boracic acid for obtaining a sphere of gold. Borax and other fluxes are so fluid when hot that the gold is very liable to alloy with the platinum wire; this rarely occurs with boracic acid on account of its great viscosity, even when white hot. Boracic acid is also easily soluble in water, so that the gold spheres can be separated without loss of time.

The following rules and figures may be useful to any one wishing to adopt the system here described.

1. The weight of a sphere increases as the cube of the diameter.
2. The weight of a sphere of any substance of which the specific gravity is known is obtained by multiplying the weight of a unit sphere of water by the specific gravity of the substance and the cube of the diameter.

Constants for Use with Gramme Weights.

1. Weight of a sphere of water 0·01 m.m. in diameter = 0·000,000,000,523,6 of a grm.
2. Weight of a sphere of gold 0·01 m.m. in diameter = 0·000,000,010,210,2 of a grm.
3. Weight of a sphere of gold 0·0x m.m. in diameter, $x^3 \times$ 0·000,000,010,210,2 of a grm.
4. If 20 grms. of ore are taken for assay the number of grains of gold per ton is found by $x^3 \times 0{\cdot}008004$, in which x = the diameter of the sphere of gold in hundredths of a millimetre.

Constants for Use with Grain Weights.

1. Weight of a sphere of water 0·001 inch in diameter, 0·000,000,132,4 of a grain.
2. Weight of a sphere of gold 0·001 inch in diameter, 0·000,002,582 of a grain.
3. Weight of a sphere of gold 0·00x inch in diameter, $x^3 \times$ 0·000,002,582 of a grain.
4. 200 grains of ore being taken for assay, the number of grains of gold per ton is found by $x^3 \times 0{\cdot}2045288$, in which x = the diameter of the sphere of gold in thousandths of an inch. By taking 978 grains for assay x^3 = grains of gold per ton.

To test the accuracy of the above figures a comparatively speaking large sphere of gold from an assay was measured and found to be 0·593 m.m. or $\frac{59{\cdot}3}{100}$ of a m.m, in diameter $59{\cdot}3^3 \times 0{\cdot}000,000,010,210,2 = 0{\cdot}002,129$ of a

* *Phil. Trans.*, 1885, Part 2, p. 704.

grm. When weighed on a very delicate balance it was found to weigh 0·0021 grm., and as this balance does not indicate beyond the fourth decimal the results may be considered identical. This sphere indicated gold in the sample tried at the rate of 3 ozs. 9 dwts. 13 grs. per ton.

The smallest sphere of gold I have yet measured was 0·024 m.m. in diameter, and by applying the above rule the weight would be $2{\cdot}4^3 \times 0{\cdot}000,000,010,210,2 \times 15{\cdot}43235$ (to convert grammes to grains) $= 0{\cdot}000,002,178$, or a trifle over two millionths of a grain.

Spheres of silver may be obtained and measured in a similar manner. The boracic acid acts slightly on the silver, but the quantity dissolved is inappreciable, as the action is not prolonged. The specific gravity of silver being 10·53, the weight of 1-100th m.m. would be $0{\cdot}000,000,000,523,6 \times 10{\cdot}53 = 0{\cdot}000,000,005,513,508$ of a grm. In a test assay made with silver the sphere measured $0{\cdot}57 = \frac{57}{100}$ of a m.m., from which the weight deduced would be 0·001,020,96 of a grm., the balance showing the weight as 0·0010 of a grm.

Copper, lead, and other metals cannot be melted in boracic acid on platinum wire without dissolving to a perceptible amount, but may with care be melted in sodic carbonate, and, by dissolving the latter in hot water, the sphere of copper, &c., obtained and measured.

Adelaide, July 6, 1886.

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 221.)

M. Boricky employs hydrofluoric acid to attack those silicates which resist the action of hydro-fluosilicic acid; he, however, prefers the latter, because when applied to the polished surface of a mineral it gives better crystals, on account of its slower and less violent action, and also because it renders it possible to estimate the proportions of the component parts when the compounds formed have the same degree of solubility. It may be also well to mention that if the substance is warmed with hydrofluoric acid, in a platinum crucible, very fine crystals are obtained: as to the quantitative estimation the author himself (p. 15) only applies it in rare cases, because the solubility of the fluosilicates varies between somewhat wide limits,* and because the different minerals do not resist the action of the acid to the same degree.

This fact, that the minerals are less easily attacked in proportion to the less amount of silica they contain, can be used to separate and isolate the different mineral species in a mixture. Thus, if we treat a rock composed of felspar and augite, in which the former predominates, at first the felspar only is dissolved, but the separation is not perfect, because augite succumbs to the action of the acid after some time. A prolonged treatment with acid is necessary in order to transform the whole mass into fluosilicates. However, this method can be used advantageously when time is of no importance.

Four hours suffice for the conversion of felspar by hydro-fluosilicic acid at 3 per cent, but six or seven hours are necessary to effect the same with augite or amphiboles. As for mica, it is better to treat it with a mixture of hydro-fluosilicic acid, with a little hydrofluoric acid added to it.

If we do not wish absolutely to operate on polished surfaces, hydrofluoric acid can be used with advantage. The powdered mineral is decomposed in a few minutes by digesting it with this reagent in a platinum crucible. If, after the addition—to make more sure—of a little hydro-fluosilicic acid, we evaporate to dryness and extract the residue with boiling water, and then place a drop of the solution on a plate of glass, we soon see the different crystals separate out.

It is clear that in this method of examination we might limit ourselves to using much smaller quantities of mineral than when following M. Boricky: in fact this *savant* made use of particles as large as a pin's head, since he was contented with a partial decomposition.

The plates of glass which are used in the experiments with hydrofluoric and hydro-fluosilicic acids, or with solutions of fluorides, should be covered with a coat of some protecting material. M. Boricky employs Canadian balsam for this purpose; for if care be taken to evaporate slowly a smooth and colourless layer is left on the glass, which resists the action of hydro-fluosilicic acid, and even weak hydrofluoric acid. It would leave nothing to be desired if the little crystals did not adhere so strongly that rinsing with water will not remove them. Washing is not advisable, as it causes cracks: thus we are obliged to use a new plate for every experiment. This constitutes, in my opinion, a real disadvantage in M. Boricky's method.

Let us now pass over the examination of felspars, the principal point of which is the detection of alkalies, and let us consider for a short time the analysis of augites and amphiboles: we shall now find the principal defects in M. Boricky's method. In this class of test we want chiefly to find and estimate calcium, magnesium, and iron; and, secondly, to try for the presence of aluminium.

Fluosilicate of lime is a very soluble salt. M. Boricky states that the crystals of this salt can be transformed, by means of sulphuric acid, into a mass of needles of sulphate of lime; and M. E. Fleischer (*Titrirmethode*, pp. 34, 35) uses this salt as a reagent instead of hydro-fluosilicic acid, for the precipitation of potash and soda. We can thus easily understand that the fluosilicate of lime does not crystallise until long after the analogous salts of potassium and sodium; but I have often detected the presence of lime in two or three minutes by means of sulphuric acid, when hydro-fluosilicic acid had given no result whatever.

According to M. Boricky (p. 23) fluosilicate of sodium may possibly contain lime. This remark is quite true; but the same is also true with regard to fluosilicate of potassium, which, when separated from a mixture rich in calcium, forms crystals of gypsum on the addition of sulphuric acid, although in less quantity than the sodic salt. The cause of this phenomenon is evidently the presence of the concentrated mother-liquor, which contains fluosilicate of lime; the salt of sodium, because of its microlithic structure, being much more apt to absorb this mother-liquor than the corresponding salt of potassium.

Fluosilicate of magnesium has the same crystalline form as that of iron and manganese: we therefore expect to find, as in the case of the carbonates, mixtures of crystals forming in the solution, containing the three compounds in isomorphous combination. This, however, does not always happen to be the case. In fact I have seen fluosilicate of magnesium which was only slightly coloured by sulphide of ammonium, separate from a solution which contained as much iron as magnesium. A much greater disadvantage of this salt is its extreme solubility in water. It forms crystals with great difficulty and after a long time only, and they are very deliquescent, which property they possess in common with the ferrous salt. The want of a good method for the detection of magnesium is the principal reason which led me to try and find a new micro-chemical method.

With respect to aluminium M. Boricky (p. 15) affirms that it does not form a crystalline compound with hydro-fluosilicic acid. The fluosilicate of aluminium will not crystallise; its solution leaves a thick glutinous mass on evaporation. However, it has been found, according to M. Deville,* that the salt is not always formed. In fact,

* Potassic fluosilicate dissolves in 833 parts of water at 17·5° C.; the sodic salt requires 153 parts, and the lithic only 1·9 under the same conditions. The salts of calcium and magnesium are also extremely soluble.

* Würz, "Dictionnaire de Chimie," article on Aluminium and Fluorides.

with excess of kaolin, hydro-fluosilicic acid forms fluoride of aluminium, and this reaction is favoured by the presence of alkaline fluorides, which, combining with the previous salt, produce chemical compounds which are quite stable and almost insoluble. If we employ a mixture of hydro-fluosilicic and hydrofluoric acids to attack the mineral, and if that contains a sufficient quantity of alkali, we can rely upon obtaining the aluminium in the form of a double salt.

Probably M. Boricky did not pay much attention to these latter bodies, because they have exactly the same crystallised form as the corresponding fluosilicate. The fluo-aluminate of potassium resembles closely the fluo-silicate of potassium; fluo-aluminate of sodium forms the same hexagonal crystals (∞ P. P.) as the corresponding fluosilicate. I have satisfied myself that the prisms crowned with a pyramid are doubly refracting, while the hexagons disappear between two inverted Nicols.

I have repeated these experiments several times with different samples, prepared with regard to the crystalline form of kryolite, which, according to M. Descloiseaux, belongs to the triclinic system. As to this last mineral, which has three planes of cleavage perpendicular to one another, I have not succeeded in observing the known lemniscates; under the polarising microscope the plates show the phenomena of polarisation which are proper to crystalline masses.

(To be continued.)

VOLUMETRIC DETERMINATION OF SULPHATES WITHOUT STANDARD SOLUTIONS.

By H. QUANTIN.

The determination of sulphuric acid as barium sulphate requires minute precautions, none of which can be omitted without inconvenience, and the attempt has therefore been made to substitute for it different volumetric methods. The alkalimetric method proposed by Mohr requires two standard solutions, and a washing of the precipitate which deprives it of every advantage as regards rapidity. The procedures in which a single standard solution of barium chloride is employed are troublesome on account of the frequent trials necessitated by the slow precipitation of the barium sulphate, and there arrives a point when the liquid precipitates equally with barium chloride or with sulphates, a circumstance unfavourable to precision. The most convenient process consists in precipitating the sulphuric acid with a known excess of barium chloride and determining this excess by means of a standard solution of neutral potassium chromate. Here we still require two standard liquids, and the slowness with which the precipitate of barium chromate is deposited renders it difficult to seize the yellow tint which marks the end of the process.

The method about to be described avoids the inconvenience inherent in standard solutions: the determination is effected in a clear liquid and the conclusion is marked by the sensitive reaction of ferrous salts with potassium ferricyanide. The method is based upon the following considerations. If, to a hydrochloric solution of barium chromate we add a solution containing sulphates, the sulphuric acid takes possession of the baryta and sets at liberty an equivalent quantity of chromic acid, which remains combined with the alkali of the sulphate. Now barium chromate is entirely precipitated by a suitable addition of ammonia. If, then, we neutralise with this alkali the solution into which has been introduced the sulphate, barium chromate will be precipitated and there will remain in solution a quantity of alkaline chromate equivalent to the sulphate introduced. If, therefore, we add to equal volumes of the solution of barium chromate, on the one hand, pure potassium sulphate in known quantity, and on the other hand a solution containing sulphates and denoting by p and x the quantities of sulphuric acid brought into play, it is clear that p and x will be proportional to the weight of chromic acid remaining in solution in either case. Hence it results that if we neutralise with ammonia and then bring the two chromic solutions to the same volume, equal fractions of the filtrates will contain quantities of chromic acid proportional to the weights of sulphuric acid precipitated. We may, by the aid of these solutions containing sulphuric acid, peroxidise a solution of iron sulphate, and the volumes n and n_2 of ferrous liquid necessary for the complete reduction of the chromic acid to chromium sesquioxide will be themselves proportional to p and x, whence it results that we have—

$$\frac{p}{x}=\frac{n_1}{n_2}, \text{ whence } x=p\,\frac{n_2}{n_1}$$

formula which, with correction, becomes—

$$x=p\,\frac{n_2-n}{n_1-n}.$$

Preparation of the Solution of Barium Chromate.

Barium chromate disssolves with difficulty in dilute hydrochloric acid; hence it is obtained in the following manner. We make:—1, a solution of neutral potassium chromate containing, per litre, an equivalent of this salt and 100 c.c. of pure hydrochloric acid; 2, a solution of barium chloride containing also an equivalent per litre. The two solutions are mixed in equal volumes, and we filter to separate the barium sulphate, which is sometimes formed in consequence of the presence of potassium sulphate in the chromate. The red liquid thus obtained is that used in the determination, and it must have the following properties:—(1) If neutralised with an excess of ammonia it must yield no precipitate on the subsequent addition of potassium sulphate; 2, if we precipitate 100 c.c. of the solution with ammonia, make up the whole to 1000 c.c., and take 100 c.c. of the clear liquid, not more than 0·2 to 0·5 c.c. of the iron solution should be required to reduce totally the slight excess of chromic acid which it contains; 100 c.c. of this solution precipitate, theoretically, 4·3 grms. potassium sulphate; by reason of the habitual precipitation of barium sulphate prepared at the moment of preparing the liquid, it is well to operate only on 4 grms. potassium sulphate. If it were necessary we might add to the solution a suitable quantity of barium chloride and potassium chromate, so that the liquid precipitated by the ammonia should always contain a trace of alkaline chromate and never of barium. The variations which may occur further in the composition of the liquid are of no importance, since it is not titrated in the strict sense of the term.

Manner of Operating.

Into a flask marked at 1000 c.c. we introduce successively 500 to 600 c.c. of distilled water and 4 grms. of pure potassium sulphate containing $p = x$ of sulphuric acid. When dissolved we introduce by means of a pipette 100 c.c. of the solution of barium chromate and agitate for ten minutes, and then neutralise with an excess of ammonia very free from sulphate. After the precipitate has settled the liquid ought to be yellow and never *reddish* (arising from an insufficiency of ammonia). It is agitated afresh and made up to 1000 c.c. After having carefully ascertained that the mixed liquid is homogeneous it is carefully filtered through Swedish paper so as to obtain a liquid absolutely limpid. It is ascertained by testing a fraction of the liquid previously acidulated with hydrochloric acid, that all the sulphate has been precipitated; 100 c.c. are then taken for determination and mixed with 10 c.c. of pure sulphuric acid, of full strength. The iron liquor is then poured in by means of a graduated burette which can contain 35 c.c. The original red tint of the solution becomes brownish, green, and finally a bluish green. It is only when every trace of yellow has dis-

appeared that we proceed to the spotting-tests. These are performed in the following manner:—The liquid being energetically stirred up by means of an agitator so as to thoroughly mix all the layers, we take a drop of the solution at the end of another rod, which must not be plunged into the liquid above 1 c.m. at most. The drop is then placed upon a drop of potassium ferricyanide, which is deposited beforehand upon a greased plate. The operation is completed, when a light blue tint appears, which must be distinct, but not deep. The solution of ferricyanide must be fresh, and so dilute that the drops appear colourless, and it must not be turned blue by ferric salts. A suitable solution is readily obtained by passing a current of chlorine into a solution of commercial ferricyanide, and expelling the excess of chlorine by boiling.

We then operate in exactly the same manner upon the solution of the sulphates to be analysed.

Before each series of determinations we determine the correction necessitated by the presence in the chromic liquid of a slight excess of chromate by introducing into a flask marked at 1000 c.c., 100 c.c. of the solution of barium chromate, precipitating with ammonia, making up to 1000 c.c., filtering, and proceeding as above. If the value found for n (referred to pure potassium sulphate) has changed little since the foregoing operations, it is useless to re-determine the correction n. We have thus to effect $p+1$ operations for p determinations. An hour suffices for completing three or four analyses. The method just described supposes that the substance submitted to analysis contains merely bodies which do not precipitate barium chloride and give no coloured reaction with ferricyanide. All cases may be brought to the above by operating as follows:—We weigh out 8 grms. of the substance, which are then dissolved in a minimum of hot water. We add a slight excess of ammonia, which precipitates the metallic oxides, which are afterwards redissolved in a little nitric acid containing ferric nitrate. The solution is again precipitated by ammonia, adding a little sodium carbonate (excess of which must be carefully avoided), and the liquid is evaporated to dryness; at about 300° all the oxides proper, such as iron and alumina, along with silica and phosphoric acid, are rendered insoluble; the organic matters, if any, are destroyed, and the presence of sodium carbonate prevents the sulphuric acid of the ammonium sulphate from disappearing if the evaporation to dryness has been carried beyond 300°. The insoluble portion is then treated with boiling water and the whole introduced into a flask marked at 250 c.c.; it is filtered and 125 c.c. are taken for analysis, that is, 4 grms. of the original substance. If the volume occupied by the insoluble portion is worth notice, it may be taken into account with 0·2 c.c. by collecting it on a filter without washing, and determining its volume after desiccation. This determination can be easily made with an approximation of 0·2 c.c. by introducing the precipitate into a flask containing 50 c.c. and making the volume up to the mark by pouring in distilled water from a burette.

Conditions of the Accuracy of the Method.

The iron-liquor, though not standardised, should present an approximate degree of concentration, as derived from the formula—

$$x = p\frac{n_2 - n}{n_1 - n}$$

n being the correction. This formula shows, in fact, that the errors being necessarily in the same direction in n, n_1, and n_2, the introduction of a subtractive correction reduces the error in reading off the burettes, since this correction bears upon both terms of the fraction. The error in reading off being, at the utmost, 0·1 c.c., the precision will be so much the greater the more considerable are the terms of the fraction, that is, the smaller is n in proportion to $n_2 - n$ and $n_1 - n$. Now $n_1 - n$ increases with p, since the quantity of chromic acid remaining in solution increases with the weight p of sulphuric acid precipitated. To reconcile these conditions of accuracy with the use of burettes, a concentrated solution of ferrous sulphate should be diluted so that $n_2 - n$ and $n_1 - n$ may be comprised between 20 and 35 c.c.

A sulphate mixed with salts of iron, aluminium, and copper yielded, on analysis, 25·3 per cent sulphuric acid in place of 25·5; the same mixed with sodium chloride and nitrate in large excess gave 25·6. The discrepancy between the results given by the volumetric method just described has never exceeded 0·5 per cent in sulphates containing 40 to 60 per cent of sulphuric acid, and it cannot be said that either of these results is preferable to the other.—*Moniteur Scientifique, Quesneville* (October, 1886, p. 1222).

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 224.)

Titration of the Uranium Solution.

The titration of the uranium solution is accomplished as follows:—

Standardising the Solution of Uranium.—Pour out in a flask (marked at 75 c.c.) 10 c.c. of standard phosphoric acid solution, measured by means of an accurate pipette, add 5 c.c. of the acid acetate of soda and distilled water to make about 30 c.c., and heat to the boiling-point. Then titrate by running the solution of uranium into the flask by means of a graduated burette, stirring after each addition, and testing the liquid, to the tenth, with some drops of ferrocyanide of potassium placed upon a greased dish. As the quantity of solution of uranium ought to be very near 10 c.c., first add about 9 c.c. without trial. Continue with two or three drops each time, until the test indicates the end of the operation.

When you observe in the last trial a sensible change of colour, refill the glass to the mark with boiling distilled water, and make a new trial. If in the first part of the operation the point of saturation has not been passed, it is generally necessary to add a drop or two of uranium solution, in order to obtain the characteristic red colour, a quantity rendered necessary by the increase of the quantity of the liquor.

This method of procedure permits one to obtain great precision the second time, whereas at first one perceives the point of saturation a little before it has really been obtained.

It is evident that the results obtained are not absolutely exact, for it has been necessary to add not only enough of the uranium solution to exactly precipitate the phosphoric acid, but also enough to give the colouration with the cyanide.

This quantity, however, can be exactly determined, since the same quantity of solution, viz. 75 c.c., is used for every determination, by making some blank determinations, *i.e.*, without any phosphates being present. The amount of uranium solution necessary to give the colouration to the ferrocyanide having been determined, it is thereafter accounted for in the titrations. The exact method of making this determination is as follows:—

The manipulation is made as in the preceding case: Into a flat-bottomed Bohemian flask of about 150 c.c. capacity, and marked at 75 c.c.; pour, by means of a pipette, 5 c.c. solution of acetate of soda; add warm distilled water, almost to the mark, and place the flask upon a sand bath heated with gas or otherwise, and carry to the boiling-point. Take it off the fire, complete the volume to 75 c.c. with a little distilled warm water, and pour in the glass one or two drops of the solution of uranium by means of a graduated burette which has been previously filled to zero. After each drop of the solution of uranium,

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

stir and try the liquid upon a drop of ferrocyanide of potassium, as has been previously indicated. For an experienced eye generally four to six drops are necessary in order to obtain the characteristic colouration—*i.e.*, 0·2 to 0·3 c.c. Beginners often use 0·5 to 0·6 c.c., and even more.

The only important point is to stop as soon as one certainly sees a red tint, for afterwards the intensity of the colour is not increased proportionally to the quantity of the liquor employed.

In the preceding operations three causes of error must be avoided.

The first is the error which may arise from the colouration imparted to the drop of ferrocyanide of potassium from the small quantity of solution removed by the stirring-rod when the eye is not sufficiently experienced.

It is very easy to determine when the end of the reaction has been reached. In order to do this, note the quantity of solution of uranium already employed and add to it four drops; stir and make a new trial upon a drop of ferrocyanide of potassium near the preceding. If the red tint does not clearly appear on taking away the rod it is fair to conclude that it was a mistake, and continue the trial. If, on the contrary, the colour appears clearly, the obtained number is taken as correct. It is always well to end the trial by this proof of four supplementary drops, which exaggerate the colour and confirm the number found.

The second cause of error, and that which, moreover, is most frequent, consists in overreaching the end of the reaction by operating too quickly. In place of giving a colour scarcely perceptible, the trial upon the ferrocyanide gives them a very marked colouration.

In this case the analysis can yet be saved.

There must be in this case a decimal liquor prepared with 100 c.c. of standard phosphoric acid solution diluted to a litre with distilled water. Add to the assay 10 c.c. of this decimal liquor and continue the titration. Account must be taken in the calculation of the quantity of phosphoric acid added.

Finally, the third cause of error is in the froth, which is often produced upon the liquid by stirring. It may retain a portion of the solution of uranium which falls on its surface and prevent its mixture with the remainder of the liquid.

If the glass rod touches this foam charged with uranium, the characteristic colour is obtained before the real saturation. It is consequently necessary to avoid, as much as possible, the formation of the foam, and above all to have a care to take the drop of the sample, after stirring, only in the midde of the liquid where the foam does not exist.

Titration of the Phosphate in the Sample of Fertilisers.

In this case, the quantity of phosphate being unknown, it is necessary to proceed slowly, so as not to pass the point of saturation. Since, in this first atttempt, a certain error must be introduced by the drops taken out for trial, the result must not be regarded as final. For the second determination, however, almost the entire quantity of reagent can be added at once, and this source of error avoided. All samples should be treated in duplicate. The committee conclude this part of their report with the following observations:—

This method of analysis, much longer to describe than to execute, gives results perfectly exact and always concordant, when it is well managed provided the titrated liquors, upon which reliance is placed, are prepared exactly and frequently verified, as we have indicated.

The standard uranium solution ought to be verified and rectified every three or four days. That of the standard phosphoric acid ought to be tested each time that the temperature of the laboratory undergoes an important change. A solution prepared, for example, in winter, when the temperature of the laboratory is from 15 to 18°, will not be exact in summer, when the temperature is 28 to 30°, at least if care be not taken to cool it before taking the necessary quantities.

The report closes with a very brief description of the methods to be used for estimating soluble and reverted phosphoric acid. These methods, especially for reverted acid, are entirely different from those recommended by our committee. As will be seen, the citrate of ammonium solution is made strongly alkaline, and the precipitation of the phosphoric acid is accomplished with a magnesia mixture in the presence of the citrate. In my opinion the method which is given below is far inferior to the procedure which has been adopted by our committee.

Preparation of the Sample for Analysis.—The sample sent to an expert chemist is prepared as we have already indicated in the previous pages; that is to say, it is poured in a sieve of which the meshes are 1 m.m. apart, and sifted upon a sheet of white paper. The parts which do not pass through are broken with the hand, or in a mortar, and added to the first portions. The product, well mixed, is introduced into a flask. In this state the mass presents all the homogeneity necessary for analysis. Some fertilisers are sticky, and in this state cannot be sifted. It is necessary, in this case, to mix them with their own weight of sulphate of lime precipitated and dried at 160°, or sand of Fontainebleau, washed with hydrochloric acid and dried, which divides them perfectly and permits them to be worked through the meshes of the sieve.

Extraction of the Products Soluble in Distilled Water.—The products being prepared as has been said, weigh from 1 to 5 grms., and put in the bottom of a glass mortar. Add 20 c.c. of distilled water, mix gently, and, after a minute, decant the part floating upon the surface into a little funnel furnished with a filter, and placed in a graduated flask of 150 c.c. This operation is renewed three times, and is terminated by an intimate mixture of the material with the distilled water. When the volume of the filtrate is about 100 c.c. the remainder is poured upon the filter and the washing continued to make the volume to 150 c.c. Stir to render the solution homogeneous, and transfer to a beaker of 300 grms. capacity.

Solution of Retrograde Phosphates with Citrate of Ammonia.—The filter is taken from the funnel, and is introduced into a graduated flask of 150 c.c. capacity with 60 c.c. of alkaline ammonia citrate prepared in the following way:—

Pure citric acid	Grms. 400
Ammonia (22°)	C.c. 500

Pour the ammonia on the citric acid in crystals in a large capsule. The mass is heated and the solution takes place rapidly. When this is complete and cool, pour it into a graduated flask of 1 litre capacity and refill just to the mark with ammonia at 22°. It is preserved for use in a well-stoppered flask. This solution ought to be strongly alkaline.

The flask in which the filter and citrate of ammonia are put is stoppered and violently shaken to disintegrate the filter and bring into suspension the reverted phosphates. Add about 60 c.c. of distilled water, shake, and set aside for twelve hours at least, and twenty-four hours at most. Complete the volume to 150 c.c. with distilled water, and, after mixing, filter.

Precipitation.—Two solutions have now been obtained which can be precipitated together or separately, according to what is desired.

The most ordinary process is to mix quantities of 25, 50, or 100 c.c., representing 0·25, 0·50, or 1 grm. of material, according to the presumed value, in a beaker with 10 to 20 c.c. of magnesia solution made as follows:—

Carbonate of magnesia	Grms. 50
Chloride of ammonium	,, 100
Water	,, 100
Hydrochloric acid	C.c. 120
Dissolve and add—	
Ammonia (22°)	C.c. 100
Distilled water ..	Q.S. to make 1 litre.

Add an excess of ammonia, and leave for twelve hours under a bell glass. The phosphoric acid contained in the liquid separates in a state of ammonio-magnesic phosphate. Gather it upon a little filter, wash it with ammonia water, re-dissolve and titrate it with the solution of uranium as previously directed.

In respect of this method, employed universally in France and Belgium, Mohr (*Chem. Zeit.*, 1886, No. 44, p. 675) makes the following observations:—The direct precipitation by magnesia of phosphoric acid dissolved in citrate of ammonia is employed a a standard method in Belgium and France. As a result of this process it is no unusual thing to find the French analyses falling from 1 to 3 per cent behind the German. He especially condemns the habit of estimating the soluble and reverted forms of the acid at a single operation. By first removing the soluble and afterward using a much less quantity of the citrate very good results are obtained. The analyses should be made as follows:—

Two grms. of the superphosphate are rubbed in a mortar with warm water and treated with a proper quantity of acetate of soda. The phosphates of iron and alumina thus produced remain with the residue in filtration. The soluble P_2O_5 is now washed out and the filtrate made up to 200 c.c. The estimation is then made in an aliquot part, 50 c.c., in the usual way. The residue is digested with an alkaline solution of citrate of ammonia for an hour at 40° to 50° C., filtered, and the P_2O_5 precipitated directly with the magnesia mixture.

In other parts of Europe we may also find associations of official chemists engaged largely in the same kind of work which occupies us here.

Chief among these bodies must be named the English Society of Public Analysts. In this society are discussed all the problems relating to the duties of public analysts, and the methods employed in analytical work receive a large share of attention. In illustration of this I may call attention to the discussion of the method of milk analysis, which has occupied so large an amount of time of the society during the past two years. As a result of this work the old methods of estimating fat in milk have been entirely superseded. The society has formally adopted the principle of Adams, which is based on a preliminary absorption of the milk by bibulous paper, and after drying rolling the paper into a coil suitable for insertion in a syphon extractor. Blotting-paper was first proposed by Adams for this purpose, but Johnstone subsequently recommended the use of thick blotting-paper, and this seems to be as successful as the first method. I have had the method partially tried in the laboratory here and with pleasing results. The filtering paper, previously thoroughly extracted with ether, is cut into strips 2½ inches wide and 2 feet long. Five c.c. of milk from a weighing bottle are dropped along the central portion of this slip of paper, being careful to leave the ends, and, if possible, a narrow margin along the sides, dry. The paper is then hung up over a sand bath or other hot place, where it becomes entirely dry in a very few minutes. It is then rolled into a coil and placed in a syphon extractor.

English analysts have found that this method gives fully 2 per cent more fat in an ordinary rich milk than in any of the old processes of evaporation of the milk with sand or gypsum.

I only mention the above to give an idea of the kind of work which is accomplished by this society, and which is so entirely in the line of our own investigations.

In Germany there are numerous societies having in general the same object in view. One of these in Bavaria has lately issued two valuable bulletins which show the general character of the work done. This society had various committees appointed for the purpose of considering different subjects. For instance, there were committees for the investigation of the methods of analysis of milk, beer, wine, drinking-water, flour and bread, butter and butter substitutes, tea, coffee, and chocolate productions, &c. All of these committees made reports at the annual meetings, and these with the discussions thereon were printed in the bulletins. In the matter of milk analysis to compare the work of the Bavarian society with that of English, the committee adopted a report which covers 114 closely printed pages. All the usual methods of analysis are carefully discussed, and the preference given finally to Soxhlet's areometric method. At the time the report was made, however, it is necessary to state that the committee had not seen the recent work of the English society to which I have alluded, and therefore made no recommendation in respect of the tables which are used for the computation of Soxhlet's method, and which are based on the old methods of the gravimetric determination of fat. It is evident, however, that if the results obtained by the English analysts should prove to be true, it will be necessary to make a careful revision of this table in order to reach accurate results by the Soxhlet method.

Having thus briefly called attention to some of the work which is carried on by societies in other parts of the world, having in general the same object in view as our own, it may be proper to remind you that the scope of our own society appears somewhat limited as compared with those metioned. It seems to me that our numbers might be materially increased and the good results of our meetings widely extended if our investigations were made to include a wider range of subjects. Every problem connected with chemical agricultural analysis falling within the range of the studies of any one connected officially with the agricultural interests of the country seems to me to be a proper theme for our discussion here. Thus all the problems relating to the adulteration of food, the general method of agricultural analysis, and all other matters which concern, in common, the analyst and the public, could be included among the duties and privileges of this body. In this way large numbers of chemists in official and semi-official life who do not feel that they are properly candidates for membership in our body could be added to our numbers. In consideration of these facts I suggest whether it might not be advisable to appoint a committee to consider the propriety of revising that clause of our constitution which limits our membership and the scope of our investigations.

(To be continued).

CORRESPONDENCE.

CONTACT-ACTION *VERSUS* CONDENSATION.

To the Editor of the Chemical News.

Sir,—Will you kindly allow me a small portion of space to suggest to Mr. Blunt (see Chem. News, vol. liv., p. 212) that he appears to have missed the drift of the paper to which he refers?

1. The oxidation of "ignoble" metals as a consequence of absorption of atmospheric oxygen belongs clearly to quite a different category of phenomena.

2. The condensation of gases in porous bodies (*e.g.*, of ammonia in charcoal) at ordinary temperatures is a fact so well known, and so often illustrated experimentally wherever chemistry is really taught, that I felt justified in taking it for granted. If Mr. Blunt, however, will reverse his experiment and heat the charcoal, after it has been carried on the mercury to the top of the tube, he will soon see that *the application of heat does not promote condensation*. Yet it is just this elevation of temperature, in the cases cited by me in the paper, which renders contact-action effective in inducing chemical action between gases which do not act upon one another under ordinary conditions.—I am, &c.,

A. Irving.

Wellington College, Berks
October 24, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 16, October 18, 1886.

Researches on the Tension of Dry Ammonium Bicarbonate.—MM. Berthelot and André.—The part played by the three components of the ammoniacal salt is not the same in its dissociation, carbonic acid and gaseous ammonia, even in great excess, not having a sensible influence upon the tension of the bicarbonate at the ordinary temperature, whilst liquid water determines its decomposition, independently of the laws of dissociation of the salt, properly speaking, and probably in the ratio of its particular combinations with the salt or with its components.

Analysis of a Cosmic Dust which fell on the Andes near San Fernando, in Chili.—E. Nordenskiöld.—The dust in question was collected in November, 1883, after a red cloud had been seen high over the summits. The mountains were, at the time, covered with fresh-fallen snow, and the weather both in Chili and in the La Plata countries had been very wet. The dust consisted chiefly of ferric oxide, nickel oxide with traces of cobaltous oxide, silica, and magnesia. The author is of opinion that it is neither a product of the Krakatoa eruption nor a terrestrial dust.

On Certain Pyridic Bases.— A. Ladenburg.— The author has obtained synthetically a number of bases of the pyridic series, including α, β, and γ-methylpyridin, $\alpha\alpha$-dimethylpyridin, $\alpha\gamma$-dimethylpyridin, α-ethylpyridin, γ-ethylpyridin, $\alpha\gamma$-diethylpyridin, and α and γ-isopropylpyridin.

Constant Presence of Microbia in the Waters of Luchon, collected at the Temperature of 64°, and on their Action in the Production of Baregine.—A. Certes and Garrigon.—The water taken at its highest temperature, and the sediments deposited at the bottom and along the margins of the tank, contain small movable rods, very transparent and difficult to observe. There are also a few longer and motionless filaments. Neither the one nor the other were accompanied by granulations of reduced sulphur. No algæ, confervæ, diatoms, nor living infusoria were present. Going further from the spring as the water cooled, both the rod-organisms and the filaments multiplied. Then only, and at temperatures not exceeding 50°, there appear those masses of baregine which are the zoogleæ of the rods mixed with grains of reduced sulphur.

Biedermann's Central Blatt fur Agrikultur Chemie. Vol. xv., Part 6.

The Oxidation of Ammonia in Waters and Soils.—J. Uffelmann.—The author proves that the oxidation of ammonia can take place without the co-operation of microbia, at least in cases of strong surface attraction. Experiments with spring water, and with the water of the Rostock town supply, showed that even in water not free from germs, and in vessels not sterilised, the oxidation of ammonia takes place much more slowly than it is commonly assumed.

Formation of Saltpetre Earths in the Tropics.—A. Muntz and V. Marcano.—From the *Comptes Rendus.*

Physiological Behaviour of Benzoic-Sulphinid (Saccharine).—A. Mosso, H. Mosso, and V. Aducco.—Saccharine introduced into the animal organism is eliminated unchanged in the urine, without producing any effect.

Conditions of the Development and the Activity of Chlorophyll.—Prof. J. H. Gilbert.—From the *Gardener's Chronicle.*

Chlorophyll and the Reduction of Carbonic Acid by Vegetation.— C. Timiriazeff. — From the *Comptes Rendus.*

Certain Conditions of the Development and Activity of Chlorophyll.— Prof. J. H. Gilbert. — From the Chemical News.

The Respiration of Leaves in Darkness.— P. Dehérain and L. Maquenne.—During respiration nitrogen is neither liberated nor absorbed. The ratio $\frac{CO_2}{O}$ is independent of the time spent by the plant in darkness. This relation within very wide limits, is independent of the partial pressure of oxygen or of carbonic acid in the ambient atmosphere. The real value of $\frac{CO_2}{O}$ increases with the temperature.

The Occurrence of the Constituents of Milk-Sugar in Plants.—A. Muntz. — From the *Comptes Rendus.*

Composition of Certain Nectars.—A. von Planta.—The nectar of *Protea mellifera* contains 73·17 per cent of dry matter, of which 70·08 consist of glucose and 1·31 of cane sugar. That of *Hoya carnosa* contains 35·65 per cent cane-sugar and 4·99 glycerin. The nectar of *Bignonia radicans* contains 14·84 glucose and 0·437 cane-sugar. Old samples of honey contain from 17 to 25 per cent of moisture, and recent samples from 20 to 33, the latter figure only in one case.

Researches on the Proportion and the Increase of Dry Matters, and of Chemical Constituents in Sinapis alba.—Dr. E. Hornberger.

Composition of White Mustard (Sinapis alba) at Different Stages of Vegetation.— Dr. Troschke.—These two papers do not admit of useful abstraction.

Cultivation of Leguminous Crops.— Beck-Antonine.—The author recommends, from his own experience, the cultivation of leguminous plants on sandy soils.

Culture Experiments with Different Sorts of Oats. Prof. Kühn, Dr. Schwab, and Administrator Menzel.—This paper is of no chemical interest.

The Proportions of Starch and Sugar in Tobacco-Leaves during Ripening and Drying.— Hermann Müller.—The author has studied the occurrence of starch in fermented tobacco-leaves, that of starch in ripening tobacco-leaves, and the behaviour of the carbohydrates on drying.

The Mosaic Disease of Tobacco.—Dr. Adolf Mayer.—The author finds that this affection is of bacterial character, and is decidedly infectious. He makes the curious statement that "the disease has hitherto been only known in England," though tobacco is not cultivated here.

Methods of Butter Analysis.—H. B. Cornwall.—From the Chemical News.

The Production of Maltose and of Maltose Syrup.—A description of two patents, the one taken out by P. Leplay and A. Cuisinier, and the other by the Société Anonyme Générale de Maltose.

The Formation of Alkaloids by the Action of Ammonia upon Glucose.— C. Tanret. — From the *Comptes Rendus.*

Journal de Pharmacie et de Chimie. Vol. xiv., No. 6, September 15, 1886.

Constitution of Pilocarpine.— MM. Hardy and Calmels.—According to the authors there exists in pilocarpine only one lateral chain in the β position opposite to the pyridic nucleus: pyridine is substituted in the α position in this chain; the chain constitutes a lactic

group, and the pilocarpine becomes the trimethyl-betaine corresponding to this acid.

The Hammam Salahine. — Julien Girard. — An account of a hot saline spring in North Africa.

Combinations of Chloral and Resorcine.—H. Causse.—In the action of chloral upon resorcine in presence of dilute sulphuric acid there are formed two series of products; the one crystalline, derived from a molecular combination, corresponding to an alcoholate, and the other amorphous, representing a combination of a polymer of chloral with a polymer of resorcine.

Artificial Colouration of Cheese.—MM. Frehse and Tissot.—The aniline yellows now used for this purpose may be extracted by means of methylic alcohol, and two solutions subjected to examination. Ethylic alcohol extracts along with the colour certain impurities which interfere with the reactions.

On Lantanine.—M. Buiza.—This base, discovered by Negrete, is obtained from a Brazilian plant belonging to the family of the *Verbenaceæ*. The composition and reactions are not given.

Reaction of Tin.—M. Bassett.—From the CHEMICAL NEWS.

On Chelidonic Acid.—M. Ernest Schmidt.—The author proves that the acid of *Chelidonium majus* is absolutely identical with succinic acid.

Presence of Vanilline in Assafœtida.—M. Ern.—Very small quantities of vanilline can be extracted from this drug.

Composition of certain kinds of Nectar.—A. Von Planta.—Already noticed.

The Action of Cafeine.—A. Langgaard.—The author finds that cafeine is to a certain extent an antidote to curare and similar poisons. It has also the same action with respect to conicine and the poison of mussels.

Ptomaine Extracted from a Poisonous Cheese.—V. C. Vaughan.—A notice of the symptoms produced by the ingestion of tyrotoxicon.

MISCELLANEOUS.

The Manchester Jubilee Exhibition, 1887. — We understand that it has been decided that the time during which applications for space can be received from intending exhibitors shall be extended to December 1st.

Exhibition of Rare Chemicals.—At the last meeting of the Society of German Naturalists a large number of chemical compounds were exhibited by Dr. Theodor Schuchardt, of Görlitz. They were principally organic compounds, but among the inorganic exhibits we note some of the rare metals, such as tellurium, gallium (fused and crystalline), indium, and germanium, and some of their rarer salts.

Paste for Labelling.—L. Eliel.—1. Tragacanth 1 oz., gum arabic 4 ozs., water 1 pint; dissolve, strain, and add thymol 14 grains, glycerin 4 ozs., and water to make 2 pints. Shake or stir before using it.

2. Rye flour 4 ozs., alum ½ oz., water 8 ozs.; rub to a smooth paste, pour into a pint of boiling water, heat until thick, and finally add glycerin 1 oz., and oil of cloves 30 drops.

3. Rye flour 4 ozs., water 1 pint; mix, strain, add nitric acid 1 drachm, heat until thickened, and finally add carbolic acid 10 minims, oil of cloves 10 minims, and glycerin 1 oz.

4. Dextrin 8 parts, water 10 parts, acetic acid 2 parts; mix to a smooth paste and add alcohol 2 parts. This is suitable for bottles or wood, but not for tin, for which the first three are likewise adapted.

A paste very similar to 3, but omitting nitric acid and glycerin, is also recommended by Dr. H. T. Cummings. —*Am. Journ. Pharmacy.*

Pathogenic Organisms in Water.—At the meeting of the Bavarian Association for Applied Chemistry (August 6th and 7th, 1886) Dr. Emmerich stated that pathogenic organisms quickly perish in water; only in a single case had Wolffhügel observed a longer permanence. His experiments were made at 22° and 35°, and no one drinks water at such temperatures. On the introduction of pathogenic microbia into drinking water, the struggle between them and the microbia inhabiting the water is always decided in favour of the latter. On a slip the typhus bacilli prevail, but in water the water-bacilli predominate. The bacteriologieal examination of water is only of secondary importance. In ordinary water there occur many organisms which form colonies resembling those of the typhus bacilli, but possess a smell like herrings, whilst the colonies of typhus bacilli have a nutty smell.—*Chemiker Zeitung.*

German Congress of Naturalists and Physicians.—At a recent meeting Dr. Plagge read a memoir on the Filtration of Water, in which he argued that the essential task of filtration is to free water from infectious matters. As such matter consists chiefly of bacteria, the value of a filter must be judged according to its efficacy in the destruction or removal of the bacteria present in the water. The distinction of the bacteria into pathogenous and non-pathogenous is here unimportant, since a filter which allows the non-pathogenous germs to pass will not keep back those which are pathogenous, whilst, on the other hand, we are justified in assuming that a filter which keeps back all other bacteria will give protection against infectious matters. Most of the ordinary domestic filters, and especially those containing as their material spongy iron, carbon, stone, gravel, and cellulose, do not—according to the author's observations—come up to the above requirement. On the contrary, there is generally found a marked increase of organisms in the filtering material. Experiments made with pure cultures of typhus and cholera prove that such filters allow these infectious matters to pass without hindrance. Better results were obtained with clay and asbestos filters of different constructions (Chamberland, Breyer, Olschewsky, Arnold, and Schirmer), as for a certain time they yielded water perfectly free from germs. However, it was not found practicable with any of these apparatus to obtain water perfectly free from microbia. According to Hesse, asbestos strongly compressed, and especially dense cells of clay, form a filtering material which yields water permanently germ-free. On this point the author is for the present unable to decide, since these apparatus have not been produced for practice, and he has not been able to procure such.—*Chemiker Zeitung.*

MEETINGS FOR THE WEEK.

WEDNESDAY, 10th.—Society of Public Analysts, 8. "On the Density and some other Characters of Waxes and Allied Bodies," by Alfred H. Allen, F.C.S. "On the Conversion of Starch into Glucose by means of Hydrochloric Acid," by Sidney Harvey, F.C.S.

SATURDAY, 12th.—Physical, 3. "Note on the Internal Resistance of Thermometers," by Mr. A. W. Clayden. "On the Peculiar Sunrise Shadows of Adam's Peak in Ceylon," by the Hon. Ralph Abercromby.

ERRATUM.—P. 225, col. 1, line 19 from top. *for* "Ostindioch" *read* "Ostindisch."

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By FRANCIS SUTTON, F.C.S., F.I.C.

London: J. and A. CHURCHILL, 11, New Burlington Street.

THE CHEMICAL NEWS.

Vol. LIV. No. 1407.

SIMPLE OR COMPOUND?

It is by no means an occurrence without precedent for two minds to arrive almost simultaneously at conclusions very nearly identical. Of such coincidences the present season has just furnished a striking example. A paper by Prof. A. E. Nordenskiöld, read before the French Academy of Sciences on November 2nd, a translation of which will be found in the Chemical News of to-day, repeats the suggestion which formed, so to speak, the key-note of the address delivered by Mr. Crookes before the Chemical Section of the British Association in September last. This coincidence, it need scarcely be said, is of no small value. It shows us that an idea thus occurring almost simultaneously to two investigators not working in concert may claim a higher rank than that of a day-dream.

Professor Nordenskiöld's paper discusses the atomic weight of the oxide of gadolinium, a name which he has given—somewhat unfortunately we think—to the crude earths, yttria, erbia, ytterbia, &c., contained in gadolinite and similar minerals. We say *unfortunately* because it will be remembered that the name gadolinium has already been appropriated by M. de Mariguac for the metal of his *Ya*.

Upon this mixture of earths the distinguished Swedish *savant* has been working for some time. By well-known methods he resolves it into three elements, yttrium, erbium, and ytterbium, always in association together. We may remark parenthetically that in addition to the above-mentioned "elements"—a term which we use not without diffidence—there are almost certainly present thulium, holmium, terbium (?), and one or two more unnamed bodies. This, however, only presents the argument of Prof. Nordenskiöld with greater force.

Mr. Crookes said in the Birmingham address: "From every chemical point of view the stable molecular group yttrium" (in the older sense of the term) "behaves as an element." And what is the opinion of Porf. Nordenskiöld? "That oxide of gadolinium, although it is not the oxide of a simple body, but a mixture of three isomorphous oxides, even when it is derived from totally different minerals found in localities far apart from one another, possesses a constant atomic weight." Surely the possession of a constant atomic weight is one of the most characteristic features of a so-called simple body.

But Mr. Crookes goes further. He says: "And as this is the case with one element, it is probably so in a greater or less degree with all." And again: "When we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on." Further we read: "The minerals of the class of samarskite and gadolinite may be regarded as the cosmical lumber room where the elements in a state of arrested development—the unconnected missing links of inorganic Darwinism—are finally aggregated."

There is another coincidence here too important to be overlooked. Prof. Nordenskiöld, in the concluding sentence of his memoir, says: "It seems that chemists here find themselves face to face with a problem analogous to that presented to astronomers in the origin of the minor planets." Now in the Birmingham address we find that Mr. Crookes had used the very same figure: "Others —*the asteroids among the elements*—have come into being and have survived, but only on a limited scale."

If we now sum up and generalise the teachings of Prof. Nordenskiöld as laid down in the memoir in question, we can scarcely help seeing that he calls in question the current dogma of the elements of modern chemistry as bodies absolutely simple, different in kind from all compounds and primordial, either independently created or self-existent. He evidently conceives of them as having originated. No less evidently does he question their absolute simplicity when he speaks of "substances of a kind that chemists as yet are forced to regard as elements."

In short, though not going as far as Mr. Crookes, though not suggesting any scheme for the genesis of the elements, Prof. Nordenskiöld may be considered as having given in his substantial adhesion to the principles laid down in the Birmingham address. Had this adhesion been concious on his part, following upon a study of the address, it would still have been of great value. But though writing about two months subsequently to the meeting of the British Association he does not appear ever to have come in contact with Mr. Crookes's speech, but to have been led to views so closely similar by an independent study of the "rare earths." It need not be demonstrated that this circumstance greatly enhances the weight of his support, and is an authoritative confirmation of the advice given by Mr. Crookes to young chemists at the close of his address.

ON THE RELATIVE STABILITY OF THE MONO-HYDROCHLORIDES, $C_{10}H_{17}Cl$, OBTAINED FROM TURPENTINE AND CAMPHENE RESPECTIVELY.*

By ERNEST F. EHRHARDT,
Tangye Scholar, Mason College, Birmingham.

In 1873 Riban showed (*Chem. Soc. Journ.*, xxvii., p. 154) that the isomeric compounds, $C_{10}H_{17}Cl$, might be distinguished from one another by the differences in their behaviour when acted on by water. Terpene hydrochloride is not decomposed by cold water, and only slightly at 100°. Camphene hydrochlorides are slowly decomposed by cold water, and readily at 100°, the crystalline camphene being regenerated.

Early in this year I was led by Dr. Tilden to examine these two compounds, to see whether their dissociation under the influence of heat bore any relation to the rate of decomposition by water.

To measure the dissociation the vapour density was determined at different temperatures.

Terpene hydrochloride was prepared by saturating redistilled American turpentine oil (boiling-point 156° to 160°) with hydrochloric acid gas, keeping the liquid cold. The hydrochloride was drained and re-crystallised once from alcohol, and then dried first by exposure to air, then under a bell-glass over quicklime.

The vapour densities were in both cases determined by Victor Meyer's method, using a bath of Colza oil.

The density of the terpene hydrochloride was determined at temperatures ranging from 223° to 263°.

(I.) $w = 0{\cdot}1336$. Temperature of oil-bath = 225°.
$v = 21{\cdot}0$ c.c. $t = 19°$. $P = 730$ m.m.
Vapour density = 80·9.

(II.) $w = 0{\cdot}1428$. Temperature = 223°.
$v = 22{\cdot}0$ c.c. $t = 17{\cdot}3°$. $P = 724{\cdot}7$ m.m.
Vapour density = 80·8.
Means.—Temperature = 224°.
Vapour density = 80·85.

(III.) $w = 0{\cdot}1157$. Temperature = 233·4°.
$v = 17{\cdot}78$ c.c. $t = 14°$. $P = 725{\cdot}45$ m.m.
Vapour density = 80·0.

* A Paper read before the British Association, Birmingham Meeting, Section B.

(IV.) $w = 0.1314$. Temperature 233·5° to 234·5°.
$v = 20.20$ c.c. $t = 10.2°$. $P = 722.3$ m.m.
Vapour density = 79·25.

(V.) $w = 0.1418$. Temperature = 233·5° to 235°.
$v = 22.50$ c.c. $t = 14°$. $P = 718.7$ m.m.
Vapour density = 78·25.
Means.—Temperature = 233·9°.
Vapour density = 79·15.

(VI.) $w = 0.1308$. Temperature = 240° to 242°.
$v = 21.23$ c.c. $t = 12.8°$. $P = 717.78$ m.m.
Vapour density = 76·22.

(VII.) $w = 0.1088$. Temperature = 250° to 251·5°.
$v = 19.42$ c.c. $t = 12°$. $P = 711.0$ m.m.
Vapour density = 69·77.

(VIII.) $w = 0.0964$. Temperature = 262° to 263°.
$v = 20.75$ c.c. $t = 12.8°$. $P = 733.63$ m.m.
Vapour density = 56·23.

On tabulating these results for comparison, it is seen that the vapour density decreases as the temperature rises.

(I.) $w = 0.0803$. Temperature = 225° to 226°.
$v = 20.61$ c.c. $t = 11.5°$. $P = 720.33$ m.m.
Vapour density = 47·80.

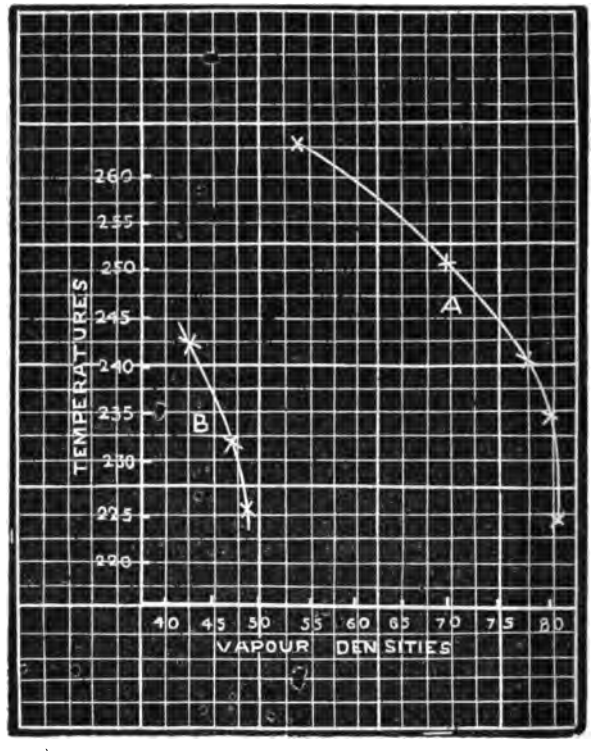
(II.) $w = 0.0658$. Temperature = 231° to 232·5°.
$v = 17.78$ c.c. $t = 13.6°$. $P = 718.14$ m.m.
Vapour density = 47·21.

(III.) $w = 0.0791$. Temperature = 242° to 243°.
$v = 21.83$ c.c. $t = 16.3°$. $P = 717.85$ m.m.
Vapour density = 45·37.

Tabulating again :—

Temperature.	Vapour density.
225·5°	47·80
231·7	47·2
242·5	45·4

Complete dissociation into $C_{10}H_{16}$ and HCl would require the density to be 43·17. That is already, at 225°, over 75 per cent of the hydrochloride has split up, and at 240° to 250° the dissociation is nearly complete. These results are represented by the curves on the diagram below, where



Temperature.	Vapour density.
224·0°	80·85
233·9	79·15
241·0	76·22
250·7	69·77
262·5	56·23

Theoretical vapour density calculated from the formula $C_{10}H_{17}Cl = 86.25$.

Hence at 224° about one-sixteenth of the compound is dissociated; at 262·5° about one-half.

Inactive camphene hydrochloride was prepared by passing dried hydrochloric acid gas through a saturated solution of inactive camphene in rectified spirit of wine, the vessel being kept cool.

The vapour density was determined in the same apparatus, at temperatures ranging from 225° to 243°, the ordinates represent the temperatures in degrees Centigrade, the abscissæ the vapour densities. Curve A relates to terpene hydrochloride, B to hydrochloride derived from camphene.

Hence camphene hydrochloride, which is more easily decomposed by water, is also less stable than terpene hydrochloride under the influence of heat.

Dr. Tilden has already shown (*Journ. Chem. Soc.*, 1884, p. 410) that, at a low red heat, the terpenes yield a considerable amount of isomeric terpilene, and at the same time partly break up into isoprene and other products. But camphene at the same temperature appeared to be more stable, and gave no isoprene.

It was therefore a matter of interest, in connection with the present enquiry, to ascertain whether a similar difference was observable between these two hydrocarbons

at temperatures not far removed from the lowest temperature at which dissociation takes place.

The vapour density of turpentine has already been determined by Weyl (*Verhandlungen d. Physiol. Gesells. z. Berlin*, 1885-6, Nos. 1, 2) at the temperature of melting lead, and somewhat remarkably was found to agree very closely with the formula C_5H_8, showing that at this temperature complete dissociation had taken place.

The following are the results of my own experiments. The vapour densities were again determined by Victor Meyer's method, but using a bath containing melted lead.

Camphene, $C_{10}H_{16}$, = vapour density 68.

(I.) $w = 0{\cdot}0472$.
$v = 11{\cdot}80$ c.c. $t = 19°$. $P = 716{\cdot}4$ m.m.
Vapour density = 49·5.

(II.) $w = 0{\cdot}0673$.
$v = 16{\cdot}45$. $t = 20{\cdot}5°$. $P = 723{\cdot}7$ m.m.
Vapour density = 51·5.
Mean = 50·5.

Turpentine, $C_{10}H_{16}$, = vapour density 68.

American turpentine, dried by calcium chloride and then re-distilled at 156° to 158° was used.

$w = 0{\cdot}0372$.
$v = 13{\cdot}39$. $t = 20{\cdot}3°$ $P = 714{\cdot}5$ m.m.
Vapour density = 34·62.

The formula C_5H_8 requires the vapour to have density = 34.

Weyl's experiments gave 39·2 and 38·6 for the vapour densities of turpentine.

Camphene, then, is much more stable than turpentine, for, whilst complete dissociation of the latter had taken place, only about 70 per cent of the former had broken up.

We have then, to account for the paradoxical result that the hydrochloride obtained from the stable hydrocarbon is less stable than that obtained from the unstable one. The following explanation was suggested to me by Dr. Tilden:—The stable hydrochloride obtained from terpene is probably a substitution compound of a hydrocarbon, $C_{10}H_{18}$. In it, then, the chlorine is probably directly combined with the carbon. The unstable compound, on the other hand, is most likely a molecular compound; in it the chlorine probably retains its hold upon the hydrogen atom of the acid at the same time that it is combined with one or more carbon atoms in the hydrocarbon.

My best thanks are due to Prof. Tilden and Dr. Nicol for much kind help and valuable suggestions.

ON THE

ATOMIC WEIGHT OF OXIDE OF GADOLINIUM.

By A. E. NORDENSKIÖLD.

As in previous communications, I mean by *oxide of gadolinium* the mixture of oxides which were first discovered in the gadolinite from Ytterby,—oxides characterised chemically by the fact of being precipitated from their solutions by ammonia, by oxalate of ammonia, and by neutral sulphate of potassium. It is now well known that this mixture, long thought to be a simple oxide, is composed of at least three oxides very close together chemically, although they have very different atomic weights. These oxides are the following:—

	Atomic Weight.*	1 grm. of Oxide gives of Neutral Sulphate.
Oxide of yttrium ..	227·2	2·056 grms.
,, erbium ..	380·0	1·632
,, ytterbium ..	392·0	1·612

Science not having yet found the means of separating elements which are so much alike, and at the same time so different in atomic weight, we are obliged, in order to be able to calculate the atomic composition of the minerals of which these oxides are a constituent part, to determine for each analysis the atomic weight of the mixed oxides.

I have recently made such a determination on the occasion of the analysis of a remarkable carbonated silicate of yttrium, erbium, and ytterbium (or of *gadolinium*), recently found at Hitteroe in Norway, and called *kainosite*. I found, on this occasion, that 1 grm. of oxide of gadolinium extracted from kainosite gave 1·922 grms. of neutral sulphate, corresponding to an atomic weight of the oxide of 260·2. On comparing this figure with the atomic weights got in the same way from oxide of gadolinium obtained from other minerals, I found to my great astonishment that the oxide of gadolinium, although it consists of a mixture of at least three oxides, whose atomic weights vary between 227 and 392 always has a constant atomic weight, whatever the mineral from which it was extracted.

The following table gives all the determination hitherto made on this subject:—

* Taking the atomic weight of oxygen as 16, and supposing these oxides to be formed according to the formula R_2O_3.

	Acids, &c, entering into the constitution of the mineral.	Approximate percentage of Oxide of Gadolinium.	Grms. of Sulphate yielded by 1 grm. of Oxide of Gadolinium.	Atomic Weight of Oxide of Gadolinium.	
Gadolinite from Ytterby	SiO_2	30	1·923	260	A. E. Nordenskiöld.
Gadolinite from Karlberg, in Dalecarlia..	SiO_2	34·6	1·908	264·2	G. Lindström.*
Kainosite from Hitteroe	SiO_2, CO_2	38	1·922	260·2	A. E. Nordenskiöld.†
Azzhenite from Ytterby	SiO_2, Ta_2O_5	33·2	1·910	263·8	N. Engström.‡
Xenotime from Hitteroe	P_2O_5	60	1·922	260·2	A. E. Nordenskiöld.
Fergusonite from Garta, near Arendal	Nb_2O_5	39	1·909	264	G. Lindström.
Fergusonite from Moss	Nb_2O_5	39	1·926	259·2	G. Lindström.
Cleveite from Garta	U_3O_4	10·1	1·909	264	G. Lindström and Cléve.‖
Fluocerite from Osterby, in Dalecarlia..		2·5	1·919	261·2	A. E. Nordenskiöld.
Eudialite from Kangerdluarsuk, in Greenland	SiO_2	0·1	1·923	260	G. Lindström.
		Mean.. ..	1·917	261·9	

* *Société Géologique Suédoise*, p. 218; 1874.
† *Ibid.*, 1886, p. 143.
‡ NILS ENGSTROM, Undersökning af nagra mineral; som innehalla sallsynta jordarter. Upsala, 1877.
‖ *Société Géologique Suédoise*, p. 218; 1878.

The oxide of gadolinium employed by me or by M. Lindström for the determinations of the atomic weights given above, was produced in the following manner:—

Dissolve the mineral in muriatic or sulphuric acid. Remove the silicic, tantalic, niobic, &c., acids in the ordinary way. Precipitate the oxides of iron, aluminium, cerium, yttrium, &c., with ammonia.

Dissolve the ammoniacal precipitate in muriatic acid, and from the slightly acid solution precipitate the oxides of cerium, yttrium, &c., with oxalate of ammonium. Filter off the precipitate, heat it to redness, dissolve in sulphuric acid, and then separate the oxide of gadolinium from the oxides of cerium, lanthanum, &c., by precipitating the latter with a saturated solution of neutral sulphate of potassium. From the filtrate precipitate the oxide of gadolinium twice with ammonia to separate the potash, then with oxalate of ammonium. The oxide of gadolinium obtained in this manner by the ignition of the oxalate, contains neither oxide of cerium, lanthanum, didymium, nor potassium.

It is easy to determine the atomic weight by transforming a weighed quantity of the oxide into sulphate by digesting it with hydrated sulphuric acid and evaporating off the excess of water and sulphuric acid until the commencement of a dull red heat. The heated sulphate dissolves easily in cold water. The solution is seldom quite clear; however, the residue is always insignificant if care is taken. If the crude mineral contains phosphoric acid, examine specially if the oxide is free from this substance; it is easily separated by repeated precipitations with oxalate of ammonium.

The minerals mentioned in the above table come from seven localities far removed from each other*; their bases are united with totally different acids; the determinations of the atomic weights have been made by different people, whose mode of operating naturally has not been quite the same. The accord seen to exist between the atomic weights of the mixture which I have called oxide of gadolinium, extracted from ten different minerals is very remarkable. It is quite as close as the accord between the determinations by different chemists of the atomic weights of most of the better known elements. The greatest divergence from mean is here 1 per cent, while, for example, the atomic weight of aluminium has been altered of late years about 1·5 per cent, that of oxygen 0·25 per cent, that of nickel 1 per cent, and that of magnesium 5 per cent. The variations in these cases are within the limits of observation, while in the case of oxide of gadolinium they are due to the difficulty of eliminating entirely the excess of acid by heat, without forming traces of basic salt, and of completely separating by means of sulphate of potassium the oxides of cerium, &c., from oxide of gadolinium. I am therefore perfectly authorised in saying:—

That oxide of gadolinium, although it is not the oxide of a simple body, but a mixture of three isomorphous oxides, even when it is derived from totally different minerals found in localities far apart from one another, possesses a constant atomic weight.

Still, we have here to do with an isomorphous mixture and not with a true chemical compound. We are, therefore, in presence of a fact altogether new in chemistry and mineralogy. It is true we have thousands of instances of isomorphous oxides reciprocally replacing each other, as, for example, oxide of iron and alumina, or lime, magnesia, protoxide of iron and of manganese; but this is the first time we are confronted with the fact that three isomorphous substances, of a kind that chemists as yet are forced to regard as elements, occur in nature not only always together, but in the same proportions. It seems that chemists here find themselves face to face with a problem analogous to that presented to astronomers in the origin of the minor planets.—*Comptes Rendus*, vol. 103, p. 795, Nov. 2, 1886.

* Ytterby is situated on the western side of Sweden; Karlberg and Osterby in central Sweden; Moss is to the east of Christiania (Norway); Garta and Hitteroe are in the southern part of Norway; Kangerdluarsuk is in Greenland.

NOTE ON PROF. L. SMITH'S PLAN FOR ESTIMATING THE ALKALIES IN SILICATES.

By PHILIP HOLLAND,
Public Analyst for Southport.

HAVING had occasion, at times, to estimate the alkalies in silicates, I adopted the plan of fusing them with calcic oxide and chloride, strictly following the instructions of Lawrence Smith. This method is probably sufficiently familiar to most analysts, and need not be set down here.

Those, however, who may not be conversant with the scheme in detail, I would refer to "Select Methods in Chemical Analysis," Ed. 2, p. 28, *et seq.*

The few experiments that form the matter of this note were recently made just to test the process in one or two particulars which I had not done hitherto.

On turning to the English translation of Fresenius, Ed. 7, vol. i., p. 353, will be found the amounts of $Ca''CO_3$, recommended by Smith and by Deville, with which to fuse one part of a silicate. The French chemist, as all are aware, has, antecedently to Smith, used lime for opening up silicates, but, according to the latter, for a somewhat different purpose to himself, and this may account for the wide difference in the quantities quoted by Fresenius.

Smith remarks, after describing his own process at length "Its constant accuracy still lacked some little to render it perfect as usually an amount of alkali remained behind, amounting to $\frac{1}{10}$ to 1 per cent of the mineral used,—certainly a small quantity, but still too much to be omitted in an accurate analysis" (Smith recovers this by again fusing the residue with extra NH_4Cl, and adds it to the principal amount). The statement that one per cent of alkali remained usually behind in the residue caused me surprise, and from experiments lately made on felspathic rocks I find that all the alkali is obtainable by a single fusion, in their case at any rate. I said, above, that I strictly followed Smith's instructions. This was so in all important points, as for instance in the preparation of the precipitated $Ca''CO_3$ (powdered Iceland spar not answering so well), the use of his form of crucible, the manner of heating it, and duration of the fusion. I should state that my reagents contained a little alkaline salts, deriving them, no doubt, from the bottles in which their solutions are preserved.

This trace, if I may use the term to indicate 2·8 m.grms., was first estimated in the total amount of reagents used, which was the same for all the later experiments, and was allowed for.

The blank trials, of which I am now speaking, were made on a mixture of 6 grms. of $Ca''CO_3$ with 0·75 of NH_4Cl, this being the one that Smith uses to decompose 1 grm. of a silicate. The crucible containing it was heated gently at first and then strongly for the time specified, viz., forty minutes. When cold the fusion was removed and extracted in a platinum basin, and the filtrate treated as usual for separating the alkaline chlorides.

The following are the weights of the chlorides so obtained, in which KCl was easily detected by $PtCl_4$. The major portion is NaCl:—

M.grms.
3·2
2·4
2·8

A point that seemed desirable next to establish was the loss, if any, occurring when a known weight of mixed chlorides is fused along with the $Ca''CO_3$ and $Ca''Cl_2$. It

Name of Silicate.	Mixed Chlorides.	K_2PtCl_6.	K_2O.	Na_2O.	Mixed Chlorides obtained on re-fusion. M.grms.
Basaltic rock, " Cader Idris," N. Wales	13·05	21·34	4·19	3·46	4·0
,, ,, " Dunmail Rise," Westmoreland..	11·18	10·10	1·95	4·29	3·2
Leucitic rock, Rieden, Germany	24·72	42·33	8·17	6·25	3·4
Red spongy lava, Pompeii	14·34	31·44	6·07	2·51	3·8
Syenite, " Yr Eifl," N. Wales	16·36	21·82	4·21	5·14	2·9
,, Nevin, ,, ...	16·17	17·99	3·473	5·662	3·6
,, ,, ,, ...	16·24	17·98	3·471	5·700	4·0
,, ,, ,, ...	16·30	18·00	3·475	5·750	3·0
,, Llanbedrog ,, ...	15·90	27·02	5·21	4·05	3·6
Vitrified ash from a bush fire, Natal	9·44	27·48	5·30	0·53	

was, perhaps, too much to expect that slight loss should not occur. It is, however, hardly of any account, as will be seen presently.

The mixed chlorides, consisting of pure KCl and NaCl fused together and powdered, had the following composition :—

	1.	2.	Mean.
KCl..	54·072	54·117	54·094
NaCl	45·928	45·883	45·905

In one experiment I took of this 0·2362 grm., and in a second 0·3173, and in each instance fused with the specified weights of $Ca''CO_3$ and NH_4Cl for forty minutes. The recovered salts, *after deducting* 2·8 m.grms., weighed respectively 0·2345 and 0·3152 grm. It is, perhaps, scarcely necessary to say that when removing ammoniacal salts by ignition, the loss of alkaline chlorides may extend to several m.grms. if the operation be hastily conducted, or the dish too strongly heated by a naked flame.

The recovered salts in the first experiment weighing actually 0·2373 grms., were dissolved in water and the potassium chloride estimated by $PtCl_4$.

Found, 0·4146 K_2PtCl_6 = 0·1266 KCl, giving as the composition—

KCl	53·35
NaCl	46·64

Of the silicates mentioned in the above table 1 grm. was taken in exceedingly fine powder and thoroughly mixed with 6 grms. of $Ca''CO_3$ and 0·75 grm. of NH_4Cl. The fusion, after first heating the mixture gently to form $Ca''Cl_2$, which, according to Smith, plays so important a part in his process, lasted forty minutes.

Special care was taken that the resulting chlorides of the alkalies were pure before final weighing and separation by $PtCl_4$. The potassium salt was collected in the Gooch crucible and treated with alcohol to remove $PtCl_4$ and Na_2PtCl_6. A slight washing was also given with a solution of K_2PtCl_6 in NH_4Cl to remove any still remaining Na_2PtCl_6, and a final one with alcohol.

The conclusion to which these figures point is that fusion with lime does practically extract all the alkali at one operation, that concordant results are obtainable, and that by use of a crucible of the form recommended by Prof. Smith, the loss of salts by volatilisation is reduced to a minimum.

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 233.)

It occurred to me that we might make use of the reaction which takes place between the alkaline fluorides and fluoride of aluminium, in order to show, after the elimination of silicon as a fluoride, the presence of aluminium,—an operation which is by no means easy if we use the ordinary methods, which are not at all adapted to the use of the microscope. From this point of view it seemed to me to be necessary to study the behaviour of the other trivalent metals.

Now I found that the fluo-aluminate of sodium is isomorphous with the combinations, of sodic fluoride, on the one hand, and the ferric, manganic, chromic, and uranic fluorides, on the other. In the reaction we can substitute the chloride for the fluoride of sodium; if we use an excess of sea-salt we observe, instead of little hexagonal plates, a figure imitating a flower with six leaves, which strongly reminds us of snow crystals. Furthermore, the resemblance of the crystalline forms goes much further in the case of the fluo-salts.

The before-mentioned double salts are analogous, as to their form, with the corresponding fluostannates, fluotungstates, fluomolybdates, fluotantalates, and fluoniobates; the fluoborates, fluotitanates, and the fluozirconates, on the contrary, are sensibly different.

The sodic fluoborate resembles the fluosilicate of the same metal; the same is true of the fluotitanate, but the crystals of this latter salts are not very definitely formed. It separates slowly in the form of little rounded masses, which, after the lapse of about ten minutes, gradually take the form of a hexagon. The sodic fluozirconate appears much sooner; its crystals are four-sided pyramids.

The potassic fluoborate has the same form as the corresponding fluotitanate; both crystallise under the forms of rhombs, often having the angles truncated. The rhombic crystals of the titanate are very apt to form raphides, because of the extraordinary development of a pair of truncating planes. The fluozirconate behaves altogether differently; it appears to be only slightly soluble; it can only be obtained in the form of very thin grains: the same phenomenon was observed with the fluozirconate of calcium, whilst the fluotitanate of this metal is, on the contrary, very soluble in water.

I have dwelt at some length on these reactions, because they seemed to be able to furnish me with a means of deciding whether certain reddish yellow crystals found in gabbro, and eklogite, were rutile or zircon.

M. Marignac* has attributed to some of the fluo-salts described a different crystalline form to which I did. I therefore repeated my experiments, but always with the same results.

I think I may attribute this discordance to a difference in the development of the facets.

I have not gone more fully into this subject for the reason that the study of the fluo-salts had only a secondary interest for me, and would only keep me from the principal aim I had in view.

After being convinced that M. Boricky's method does not enable us to determine the presence of calcium and magnesium with the accuracy wished for, and that it might lead us to confound silicon with aluminium, and this latter element with boron and iron, and to a certain extent with manganese and chromium, I found it necessary to abandon it, and to try and devise another, which, although less simple and elegant, enables us to obtain

* *Ann. de Chim. et de Phys.*, vol. lx., p. 301.

results of greater certainty, and more decisive, in a shorter time and with greater ease.

4. New Micro-chemical Method.

A complete system of micro-chemical methods, in the study of petrography, ought to furnish means sufficient—

1st. For the qualitative analysis of the small fragments of minerals which frequently occur. The minimum weight of these fragments may be taken at 0·1 m.grm., which corresponds to a diameter of about 0·3 m.m.

2nd. For the qualitative search for the integral particles, at different points on the polished surface of a mineral.

3rd. For the separation of the fragments of the more common minerals, so as to complete the qualitative by a quantitative analysis.

The reactions comprised under the first of these requirements ought further to satisfy the following conditions:—

a. Filtration must be entirely dispensed with, thus preventing, as much as possible, waste of time and contamination of the substance under examination by foreign matter.

b. Chemical compounds must be formed which are easily recognisable, either by their crystalline form under the microscope or by the formation of intensely coloured precipitates.

c. The time required to form distinct crystals, during a slow evaporation, must be as short as possible; two hours at the most should suffice for these operations.

d. All the phenomena to be observed must be of such clearness and simplicity that anyone, with very little practice, can make use of them with success.

Thus it is necessary to endeavour to make use of reagents having a high molecular weight; it would even be advantageous to give the preference to those reagents which form double salts, rather than to those which only lead to the formation of simple salts of equal solubility; and further, it will be easily understood that the formation of salts containing water of crystallisation will always have an advantage over that of anhydrous salts.

5. Preparation of the Mineral for Examination.

1. When we have large quantities of the mineral available, or several samples and specimens from the same neighbourhood, it is often advantageous to detach small splinters by means of a hammer, and then pick out from the fragments all the particles of one particular mineral. I generally adopt this method when the crystals have a linear dimension of 1·5 m.m. We must then make sure, by examination with the glass, that we have to deal with particles of identical structure, colour, and brilliancy, and when necessary we must free the mineral from traces of iron by treatment with aqua regia.

2. Micro-crystalline rocks must be crushed in an agate mortar, or, when one is not available, on a small anvil, while wrapped up in paper. After having got rid of the dust by sifting or blowing gently on the powdered mineral, we must try and pick out, by the help of a glass or a low power microscope, either with a needle or a small pair of tweezers, all the homogeneous particles we can find of the mineral under examination. By moistening the needle with glycerin it is more easy to remove the small particle, and by then plunging the point of the needle into water the mineral will drop off.

3. In cases when we cannot easily distinguish the integral parts of the rock in the accompanying substance, we make use of a plate sufficiently thin that it has enough transparency to be used with a microscope multiplying 100 times. The plate must be slightly polished, to effect which we must stop adding emery, and, on the contrary, keep adding water, while rubbing the mineral on the plate with a gentle circular movement, until there is nothing left between the mineral and the plate of iron on which it is being ground. In certain cases we can give the plates the transparency necessary for use with a lower power microscope, by moistening them with glycerin or olive-oil.

In microscopic researches it is necessary that the Canada balsam which is between the mineral substance and the slide should have a certain softness; it may sometimes be necessary to bring this about by gently heating.

We can now detach under the microscope (making use of an object-glass of low, and an eye-glass of high, power) small particles of the mineral by the aid of a small thin blade, or a large needle ground flat at the end so as to form a knife, so that the cracks will not spread far from the field of vision. We must operate by commencing at the edge and gradually advancing to the centre, and then, by heating rather strongly and scratching on the surface, we are able to remove the particles of foreign matter which are detached. We can in the same manner remove the segment of the mineral required for the experiment, and by heating it strongly drive off all organic matter. Finally, the little particles of adhering matter can be got rid of in the manner described above (No. 2).

In order to facilitate the action of the chemical reagents the mineral must be reduced to a very fine powder, and to prevent loss the lumps must be covered with paper before breaking them up in a steel mortar. The paper can be removed with the aid of a steel or horn knife, but glass, porcelain, or bone must never be used. The steel blade can also be used to collect the powder adhering either to the pestle or the mortar.

(To be continued.)

THE HISTORY OF CALIFORNIAN BORAX.

By ARTHUR ROBOTTOM

Sir Edward Bulwer Lytton, in the "Last Days of Pompeii," bears testimony to the value set upon borax in the days of the Roman republic. "Borax," says Sir Edward, "was largely used by Nero and his slaves near 2000 years ago, and Pansa deeply regretted that he was not rich enough to buy borax to cover the arena after the death of the combatants at the time of the fight between Lydon and Tetraides." Many a time since my visit to the Californian borax districts has this passage sprung into my mind, and often I have thought what a pity it was that Olanthus, Glaucus, Caligula, and the gladiators did not know of the existence of the great borax lake in Slate Range Mountains, California.

My visit to this lake was one of the most interesting journeys I think I ever made in my life, and the accident of my making this journey arose in the following manner. In the year 1874 I visited the borax deposits in Nevada, and was on my way to San Francisco, when during the journey I was interviewed by a reporter of a Winnemucca newspaper, who, without my knowledge, sent on to San Francisco the following particulars concerning my visit in his paper, and which were duly reproduced before my arrival in the "Californian Alta," of San Francisco:—

"Mr. Arthur Robottom, of Birmingham, England, paid our town a visit a few days ago, on a prospecting tour, to discover if any borate of soda or borate of lime exists in this section. He was much struck with the number of hot springs that are to be found all through the Humboldt Valley. The borate of soda and borate of lime are known to exist at Hot Springs station on the Central Pacific Railroad, also at Columbus and other parts of this State; and no doubt if the hot springs of Humboldt Valley should prove to give off vapours that produce boracic acid, or that borate of soda is to be found in the alkaline beds which exist all over the district, a new and profitable trade will spring up. The article of borax has been well known all over the civilised world; still but

few people know anything of its origin. In 1818 Count Lardarel discovered how to prepare boracic acid from the Lagoons of Tuscany, and made a princely fortune by it. This boracic acid was shipped to England and France and converted into refined borax by boiling in large pans, and crystallising in vats. Tincal was the artical used in making borax before boracic acid was discovered. This article is found on the dreary plains of Thibet, in Asia, and sent on sheeps' backs across the Himalaya Mountains to Calcutta, and thence to England. About 20 years ago borate of lime was discovered in Chili, and found its way to England, Mr. Robottom being one of the first to introduce it into that country. Mr. Robottom will also visit the Hot Springs, Wadsworth, Columbus, and San Francisco." The result of this having appeared was that the morning after my arrival in San Francisco my hotel was fairly besieged with persons who were anxious to interview me in my capacity as a borax expert. After many interviews with individuals who professed to hold land said to be rich in borax, I decided to visit and inspect the great Slate Range district, and after making all my arrangements I left San Francisco, proceeding southwards by steamer down the Pacific coast, and after a pleasant journey arrived at Los Angelos or City of Angels, an old Mexican town. Los Angelos is now, however, peopled principally with Americans, who drive a considerable trade with the teamsters who visit the interior. At this time the Southern Pacific Railway was not made, and this section of the country could be traversed only by the aid of mule teams; the Slate Range lay about 240 miles inland, and the whole country was infested with a band of ruffianly bandits and robbers, composed of the very refuse of society from all parts of California and Nevada. Under these circumstances I soon discovered that my only chance of travelling with any safety was to assume the rôle of what is known in this part of the world as a "busted" miner, "busted" being a convertible term for ruined, and derived probably ftom "bursted," or broken up. I was also informed that on some parts of the journey, hay was worth £50 per ton, and water two shillings per bucket, and that it would be better for me to walk, and much safer. Adapting myself to the circumstances I started in my disguise and travelled with a mule team over a very rough country at the rate of from 12 to 14 miles per day, and arrived at length, without any remarkable adventure, at the shanty kept by Jim Bridger, some 42 miles from the Slate Range, and which is situated on the main road to Cerre Gorda, a wild looking spot, without any other road, the country being covered with the oleaginous plant known as greasewood, and the only animal life being represented by the dismal owl and the deadly rattlesnake! Not a very pleasant prospect, I thought, but I afterwards found when sleeping out in this part of the country that by surrounding myself with the ashes of a greasewood fire or a horsehair rope, that as far as the rattlesnakes were concerned there was no danger, as these reptiles, strangely enough, will never cross the ashes of a greasewood plant, or a rope made of horsehair. While as to the owl his existence was naturally a pure matter of indifference to me, so far as my comfort was concerned.

Rather a curious incident occurred to me while staying at Jim Bridges': a pioneer and prospector had come from the mountains to get a few supplies from the store, when he saw me sitting on a bench outside, and after a few words had passed, he remarked, "Why you are from the Old Country, and pretty green too! whatever brings you into a country like this? You are no miner! Have you been writing somebody's name on a bit of paper, or done some act as you're afraid of the Sheriff; or are you on the wrong side with the other sex?" My reply was that I was all right on these points, and had come out here prospecting for borax. He at once begged me to have nothing to do with it. He said, "There is plenty of it, but no one knows what it's good for." He had been down to Death Valley, and to the foot of the hills of the Slate Range, through Owen's Valley, and to Mono Lake, and he gave me much information about this "howling wilderness."

After a short stay at Jim Bridger's shanty I again proceeded, steering for the Foot Hills, some 22 miles from the shanty, then onward through a great canon, or divide, partly covered with salt, on emerging from which I found myself on the border of the most important borax lake yet discovered in the world. I was met by John and Dennis Searle, two men belonging to the Californian discovery army that sprang into existence in the year of 1849, and whose members are known by the name of "Forty Niner's." These men, masters of almost every kind of handicraft, had made their way to this great lake with a view to exploration. Consequently, though I can claim to be the first Englishman who visited the borax lake, the honour of its discovery does not rest with me. I stayed some time in the hut of these men, and together we examined the ground. I very soon discovered natural borax of the finest quality in a pure state, and though Messrs. John and Dennis Searle had begun prior to my arrival to develop the ground, the first shipment was made by me to England. The borax I found was crystallised borax, in the same form as the regular borax of commerce, and is the only known deposit of natural borax yet discovered in the world. In the centre of the lake is a bed of salt about five miles long; on the outside of this salt is a deposit of carbonate of soda, and some thousands of acres of land covered with crude borax, from three inches to two feet thick. The crude borax is collected and put into cowhide baskets, carried to a large boiling-pan, and boiled for 36 hours; the solution is then run into vats and the crystals form on the sides of the vats. After drying it is put into bags, about 70 lbs. in each bag, and sent to San Francisco, a distance of about 420 miles, and conveyed at that time by mule teams. Before leaving California I arranged to buy 1280 acres of this borax land; I returned to England as quickly as possible, made arrangements to go out again, formed a small company who put up works, and I anticipated making about a million by it, and before long we began to ship large supplies of borax to Liverpool, London, and New York. The price, however, suddenly came down to £26 per ton, the lowest price it had ever been sold for, while the carriage alone from the lake to San Francisco at this time was about £16 per ton of 2000 lbs. This was a paralysing condition of affairs that quite stunned me. I had made a very large contract for some hundreds of tons to a large firm in England, but before the arrival of the ship with the first parcel the firm failed, and I found myself, to my horror, with some hundreds of tons of borax left on my hands that I could not get rid of, the bankers and financial houses holding the documents all pressing for sales to be made! My golden dream of making a million faded away, and left me meditating the bitter realities of impending ruin! (I yet anticipated that this property will at some future period be worth £1000 per acre. Experience has proved that the crude borate of soda on the surface of the land reproduces itself every three years.). As soon, however, as I had somewhat recovered from my shock I began to realise that I must do my utmost to find a market for the borax. I was driven to every move that a man could suggest to try and begin to get clear of the stock. I knew that if the public could only be made to understand the true merits of the article, and would begin to try it, all would come right for myself and friends. Consequently I set to work, and began to have the ground borax packed in penny packets. Here again I met with disappointment, for I soon found out that the public are very slow in taking to a new article, and I could not induce the retail shopkeepers to sell it. I offered it to the druggists, they all replied "you want us to sell far too much for a penny, we want eightpence for what you want a penny for; 25 per cent profit won't pay us." I then tried the grocers; they were satisfied with 25 per cent profit, or less, but their reply was as characteristically disheartening. "It's all right," they said, "but borax is some kind of medicine, not a

grocer's article, we can have nothing to do with it—it's too much trouble to tell the customers its merits." The whole business began to look very dark and gloomy; almost in depair I took a stand at the first dairy show in the Agricultural Hall, and met with marvellous success. I then tried many of the laundries in and about the suburbs of London, and I also tried many of the hospitals and other public places with more or less success.

A lady, universally known from her philanthropy, sent her almoner to see me about it, and a specimen was sent by her desire to one of the first scientists of the day; but the true merits of borax were not then known even to the wisest of the wise. My belief in the borax, however, has never deserted me. I made many experiments and collected much information as to its uses, and the consumption during the last few years has very considerably increased; but this has only occurred since I parted with my interest to the Patent Borax Company of Birmingham, who have naturally been enabled to bring the product more forcibly to the front as one of the most useful and important products yet discovered in the world. I still feel a very keen interest in the future of this product, though I have no pecuniary end to serve in saying so; but the multiplicity of its uses is truly marvellous, and the following information cannot, in my humble opinion, have too extended a circulation. For the laundry there is a very great deal of labour saved by using borax, as this product "softens" the dirt, and the latter may almost be said to float out of the linen, saving at once the destructive friction, and the time and materials. For the household its uses are legion; beds, &c., washed with a strong solution of borax in the spring, prevents insect life from forming; dusting the floors with dry borax destroys the larvæ of the moth, and keeps the carpets entirely free from insect life. For cleaning marble, plate, jewellery, decanters, plates; for improving the flavour of boiled vegetables, tea, &c., and preserving eggs, fish, butter, and milk, borax, in one or other preparations, is simply invaluable. It is the best tooth-wash known; will clean brushes, sponges, &c., from dirt. Medicinally the value of borax is not as fully known as it should be. I hold letters from eminent medical men who have corresponded with me upon its value, and who esteem it highly. The *Lancet*, of May 20th, 1876, contained a laudatory article on it as a valuable antiseptic "which does not irritate and inflame." I have cured thousands of persons suffering from sore throat, by giving them a small piece of borax to suck (I always carry a bit in my pocket wherever I go); and for dissolving the phlegm and clearing the throats of speakers, my own experience proves to me that it is the only reliable remedy.

Since the first publication of the above, extensive progress has been made in the development of the uses of borax by the general public; and from letters, the thanks and encouragement I am receiving from many friends and strangers satisfy me that I have given information which well repays me for all the trouble, losses, and the inconveniences I have been put to in trying to make this wonderful production better known.

Touching the labour uses of borax, it is mainly used in glazing all descriptions of porcelain, china-ware, pottery, &c. Blacksmiths use it for welding iron and steel. It is used for welding the seams of copper and iron tubes; in the manufacture of hats, jewellery, artificial diamonds, and the plates for affixing artificial teeth. The finest marble cement is made from borax. Farmers, graziers, &c., use it for washing cattle; and provision merchants for arresting or preventing decomposition in their hams, &c. The foregoing will, I trust, awaken people to an interest in this most valuable product of the earth.

Native Borax.—Analysis:—

Sodium biborate—pure	99·75
„ chloride—trace only ..	0.25
	100·00

The following are the rates of wages paid for labour in this section:—

	£	s.	d.	
Blacksmiths	1	0	10	per day.
„ helpers	0	12	6	„
Engineers	0	16	8	„
Teamsters	0	13	6	„
Coopers	0	13	6	„
Boilermen	0	10	6	„
Watchmen	0	10	6	„
Labourers, principally Chinamen	0	5	3	„

The Southern Pacific Railway Station is only about 72 miles from the Lake, where the borax is carried by 20 mule teams, but in about three years or less a railway will run within four miles of this desolate country, when these wonderful natural deposits will be more carefully examined by scientific men.

Before concluding this article, I may here state the borax lake is not a very enviable place to live in. On my first visit, Jim Bridger's shanty (42 miles from the lake) was the nearest place from which we could obtain our coffee, sugar, or canned fruits, &c., and post our letters. We had no drinkable water within 17 miles. Always a clear blue sky (a little London fog would have been a great treat). Not a tree visible; no vegetable, only the oleaginous greasewood plant. No animal life, no Indians, no clouds, no rain; and last, but not least, a total absence of the fair sex. The freight alone to build our works cost 2½d. per lb. from San Francisco.

107, Dunster House, Mincing Lane, London, E.C.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 236.)

On the conclusion of the president's address it was moved and carried that the order of business adopted for the previous meeting be continued for the present as follows:—

(1) Reports of committees:—(*a*) on Phosphoric Acid; (*b*) on Potash; (*c*) on Nitrogen—the reports to be received and discussed in this order.

(2) Determining methods to be used during the next year, in the same order.

(3) Election of officers.

(4) Miscellaneous business.

In accordance therewith the report of the Committee on Phosphoric Acid was presented by the Chairman, Dr. H. C. White, of Georgia, as follows:—

Report of the Committee on Phosphoric Acid.

The Committee on Phosphoric Acid respectfully submits the following report:—

Adopting the plan followed by the Committee last year, the report presents (1) brief notices of new analytical methods for determining P_2O_5 proposed during the year; (2) results of co-operative work done by the Committee and members of the Association; (3) recommendations for the next year.

The publication since our last meeting of the second edition (1886) of Crookes's "Select Methods in Chemical Analysis" has presented in convenient form outlines of nearly all methods for determining P_2O_5 worthy of note that have been suggested to the beginning of the current year. In addition we note as follows:—H. Joulie (*Ann. Agronom.*, ix., 97—129; Abstract Chemical News, lii, 85) re-publishes his "citro-uranic" method for estimating P_2O_5 in manures by dissolving in HCl, precipitating as magnesium-ammonium phosphate in presence of excess of citric acid, dissolving the precipitate in dilute HNO_3

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C., August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

with addition of sodic acetate, and titrating with uranic nitrate. He compares unfavourably the ordinary nitromolybdate method. The essential points in the process, with critical remarks, are given in Crookes's "Select Methods," Second Edition, 504-5 and in more detail in CHEMICAL NEWS Abstract (liii., 85). J. M. H. Munro adds to the Abstract in CHEMICAL NEWS some examples of tests of Joulie's method, indorsing it if carried out exactly as recommended.

M. Meinecke (*Repertorium Anal. Chem.*, v., 153; CHEM. NEWS, liii., 53) proposes to determine P_2O_5 by direct weighing of the precipitate of ammonium phosphomolybdate after heating for fifteen minutes at a temperature of 400° to 500° C. The composition of the black compound thus obtained is said to be constant, containing 4·018 per cent P_2O_5. Certain precautions in precipitating with molybdate solution, washing, and drying, are pointed out as necessary.

Tests of this method, made in the laboratory of the Chairman of the Committee, have given unsatisfactory results.

E. Aubin (*Comptes Rendus*, c. 1595-6; *Journ. Chem. Soc.* Abstract, xlviii., 1093) avoids the precipitation of silica, lime, magnesia, fluorine, &c., and determines P_2O_5 by immediate precipitation with magnesia mixture as follows:—The sample is dissolved in boiling HCl with addition of a saturated solution of sodic acetate in acetic acid, solid ammonic oxalate being added during the boiling. The precipitate is allowed to settle, filtered, and well washed. Excess of ammonia and solution of ammoniac citrate is added to the filtrate, which is then precipitated in the usual manner with magnesia mixture.

The Committee calls special attention to the very interesting and valuable paper of Dr. Paul Wagner (*Chemiker Zeitung*, x., 13; translated in CHEMICAL NEWS, liii., 133—136). Dr. Wagner has attempted by crop experiments to establish the relative manurial value of the "water insoluble" P_2O_5 in different classes of phosphates, compared with that of the "water soluble," and to devise an analytical method for the determination of what he calls "soluble" P_2O_5 (corresponding to what we designate "available") in either a superphosphate or a phosphate containing no "water soluble" P_2O_5 which method shall yield results corresponding to the proportionate manurial values.

The method proposed is as follows:—5 grms. of the sample are rubbed up with some dilute citrate solution poured into a half-litre flask, made up to the mark with dilute citrate solution, allowed to stand about 18 hours at the temperature of the room (13° to 18° C.), with frequent shaking, and then filtered. Fifty c.c. of the filtrate are taken and the P_2O_5 determined in the usual manner by molybdate and magnesia mixture. The citrate solutions are made as follows:—

(1) Concentrated citrate solution. 150 grms. of citric acid are placed in a litre flask, dissolved in water and neutralised with ammonia. To the neutralised solution 10 grms. of citric acid are added, and the solution made up to the mark with water.

(2) Dilute citrate solution. 1 volume of concentrated citrate solution is mixed with 4 volumes of water.

The other reagents are essentially the same as those now used by this Association.

At a meeting of the manure manufacturers of South Germany and representatives of the experiment stations of Bonn, Darmstadt, Marburg, Spier, and Wiesbaden, held at Mayence November 30, 1885, this method for the analysis of all superphosphates was unaminously agreed upon to be used from January, 1886, and the term "soluble" was adopted to designate the P_2O_5 extracted by the process indicated.

In view of the possible importance of the method suggested, should it be generally adopted by continental chemists, the Chairman of the Committee has made a few experiments to test the results given.

The samples of superphosphates A, B, and C, distributed to members of the Association, as hereinafter described, were used in the experiments.

(1.) Five grms. of the superphosphate were treated directly by Wagner's method, with the following results:—

	A.	B.	C.
"Soluble" (Wagner) ..	8·35	12·10	9·95
	8·37	12·15	10·01
	8·40	12·14	9·96
Mean.. ..	8·37	12·13	9·97

(2.) Five grms. were first exhausted with pure water as in our ordinary method of determining "water-soluble," and the residue was then treated by Wagner's method.

	A.	B.	C.
Water soluble	7·40	11·50	9·15
Obtained from residue	2·25	1·52	1·75
	2·20	1·50	1·68
Mean	2·23	1·51	1·71
"Soluble" (Wagner)	9·63	13·01	10·86

It is very evident that Wagner's method gives much lower percentages of what we are accustomed to call "available" P_2O_5 than the method now in use by us. The introduction of this method into our work would clearly be attended with many embarrassments; and yet, if Dr. Wagner's crop experiments and his conclusions are to be relied on, it is a question if his analytical method is not a proper one to employ in the official work of experiment stations and State officers. It will be remembered that considerations of a similar character led to the adoption by this Association of the temperature of 65° C. for digestion of the citrate solution in determination of "insoluble" P_2O_5.

II. Owing to absorbing engagements of the Chairman the Committee was somewhat tardy this year in the distribution of samples for co-operative work. Finally, on June 12, three samples of superphosphates were sent to each member of the Association and to others, marked as follows:—

A.—Acid Phosphate, South Carolina.
B.—Acid Phosphate, Navassa.
C.—Acid Phosphate, South Carolina and Navassa mixed.

These materials had been specially furnished by courteous manufacturers, and were carefully sifted and mixed so as to secure uniformity. In the circular letter accompanying the samples request was made that the determinations be made within the week beginning Monday, June 28.

Returns have been received from eleven laboratories, covering the work of fifteen analysts. The results in ful are here given:—

Results of Phosphoric Acid Determinations.

Analyst. Sample A.	Moisture.	Soluble.	Reverted.	Insoluble.	Available.	Total.
A ..	7·15	7·16	4·29	7·61	11·45	19·06
B ..	7·02	6·63	5·00	7·31	11·63	18·94
C ..	7·05	7·01	5·33	7·04	12·34	19·38
D ..	—	6·98	5·09	7·48	11·07	18·55
E ..	6·27	7·00	5·05	7·01	12·06	19·06
F ..	6·27	6·99	5·01	7·04	12·00	19·03
G ..	7·14	7·01	3·97	7·71	10·98	18·69
H ..	—	7·15	3·77	7·77	10·92	18·69
I ..	6·88	7·05	4·69	7·35	11·74	19·09
K ..	7·22	7·04	5·24	6·75	12·28	19·03
L ..	7·17	7·46	5·06	6·42	12·52	18·94
M ..	8·70	7·12	3·76	8·04	10·88	18·92
N ..	—	6·90	4·29	7·87	11·19	19·06
O ..	7·25	7·40	5·16	6·40	12·56	18·96
P ..	7·20	7·32	5·09	6·45	12·41	18·86

Analyst. Sample B.	Moisture.	Soluble.	Reverted.	Insoluble.	Available.	Total.
A ..	9·65	11·13	4·08	3·85	15·21	19·06
B ..	10·06	10·11	5·06	3·41	15·17	18·58
C ..	10·03	10·72	4·82	3·58	15·54	19·12
D ..	—	10·03	4·39	3·87	14·42	18·29
E ..	9·17	10·51	—	—	—	18·47
F ..	9·17	10·54	4·26	3·58	14·80	18·38
G ..	10·14	11·30	3·46	3·56	14·75	18·31
H ..	—	11·23	3·23	3·84	14·45	18·29
I ..	10·16	11·05	4·29	3·49	15·34	18·83
K ..	10 15	11·39	3·51	3·80	14·90	18·70
L ..	10·11	11·55	3·88	3·00	15·43	18·43
M ..	11·87	11·24	3·26	3·82	14·50	18·32
N ..	—	10·54	4·12	3·91	14·66	18·56
O ..	10·20	11·50	3·85	3·10	15·35	18·45
P ..	10·20	11·58	3·76	3·17	15·34	18·51
Sample C.						
A ..	10·35	9·08	4·15	5·13	13·23	18·30
B ..	10·30	8·67	4·27	4·83	12·94	17·77
C ..	10·40	8·99	4·62	4·72	13·61	18·33
D ..	—	8·68	3·50	5·40	12·18	17·58
E ..	9·62	8·70	4·17	4·91	12·87	17·88
F ..	9·62	8·75	4·23	4·68	12·98	17·66
G ..	10·15	8·84	3·44	5·23	12·28	17·51
H ..	—	8·88	3·42	5·20	12·29	17·49
I ..	10·56	8·93	4·23	4·78	13·16	17·94
K ..	10·45	9·21	3·96	4·83	13·17	18·00
L ..	10·63	9·25	5·10	3·38	14·35	17·73
M ..	12·20	9·02	2.94	5·56	11·96	17·52
N ..	—	8·76	3·27	5·77	12·03	17·79
O ..	10·50	9·15	5·20	3·40	14·35	17·75
P ..	10·61	9·23	5·09	3·43	14·32	17·75

Averages.

Sample A.	Number of determinations.	Mean.	Highest.	Lowest.
Moisture	11	7·18	8·70	6·27
Soluble	15	7·08	7·46	6·63
Insoluble	15	7·55	8·04	6·40
Total	15	18·95	19·38	18·55
Sample B.				
Moisture	11	10·16	11·87	9·17
Soluble	15	10·96	11·58	10·03
Insoluble	14	3·57	3·91	3·00
Total	15	18·55	19·12	18·29
Sample C.				
Moisture	11	10·52	12·20	9·62
Soluble	15	8·94	9·25	8·67
Insoluble	15	4·75	5·77	3·38
Total	15	17·80	18·33	17·51

(To be continued.)

NOTICES OF BOOKS.

A Natural System of Mineralogy, with a Classification of Native Silicates. By Thomas Sterry Hunt. Reprinted from "Mineral Physiology and Physiography," a Second Series of Chemical and Geological Essays. Boston: S. E. Cassino.

Mineral taxonomy has hitherto presented difficulties which, though the subject of no little discussion, have been but very imperfectly surmounted. This want of a truly scientific arrangement showing the natural relations of species is perhaps one reason why systematic mineralogy finds at present exceedingly few followers.

Two conflicting principles have been put forward for our guidance. As most of our readers are well aware, Berzelius, as far back as 1815, proposed a purely chemical system, which has since, with certain modifications, been adopted by Rammelsberg, Naumann, Dana, and others, and is now most generally accepted. In it the results of chemical analyses are regarded as of primary importance, whilst physical characters and crystalline form are relegated to a subordinate rank.

The opposite principle, clumsily called by Jameson the "Natural-History method," was proposed by Werner a century ago, and developed by Mohs, Breithaupt, Jameson, and Shephard. This system is based on the "natural alliances and differences which exist between minerals." Werner, it appears, pronounced the intervention of chemistry as a mere provisional expedient, and even doubted the possibility of constructing a philosophical system in which the external and the chemical characters should be co-ordinated.

We notice here an important difference in classifications. There are systems whose main object it is to admit of the easy determination of any given specimen, if possible without its destruction; and there are others which seek to show existing forms, organic or inorganic, in their natural relations and in their order of filiation.

We find that now certain ideas which have been first developed by the study of living beings are winning their way into chemistry itself. On the other hand, we recognise two very luminous principles put forward for the first time by Dr. Hunt. He shows that in the more highly-organised animals chemical considerations are of little value in taxonomy, whilst morphology is well nigh everything. In plants "characters depending upon chemical differences, such as the presence or absence of certain acids, alkaloids, and groups of essential oils," come in to aid us in determining the natural affinities of plants, whilst in simple crystals or amorphous masses morphology counts for little, and chemical considerations for almost everything. Hence the mineralogist who rejects the aid of chemistry commits a fundamental error.

As another principle Dr. Hunt compares carbon and silicon. He seems to have been the first to define organic chemistry as the chemistry of carbon and its compounds, and he might have viewed, in a like spirit, the structure of plants and animals as the "form-lore" of carbon and its compounds. In minerals silicon plays a part almost corresponding with that of carbon in the organic world.

Hence he proposes, as the base of his natural system in mineralogy, the following main principles:—

The conception of high molecular weights, like those of the carbon series in so-called organic chemistry, extended to all mineral compounds.

The conception that the laws of progressive or homologous series, previously recognised only in the hydrocarbons, are of universal application.

The conception that the variations observed in the chemical composition af mineral species are due not only to polybasic characters, but in some cases to indefinite admixtures of homæomorphous species.

The attempt to fix the molecular weights of such compounds as the polysilicates and polycarbonates from their densities, as compared with those of species the minimum molecular weights of which are otherwise determined; and the assumption that for homæomorphous solids, and probably for all solids, the molecular volumes are identical.

The adoption of atomic formulæ to represent the composition of mineral species, and the showing that comparisons of the volumes or spatial relations of complex species like the silicates, should be based on the numbers deduced from these atomic formulæ, which represent the relative volumes of the unit-weight in the species compared, P being the unit-weight got by dividing the empirical molecular weight by the number of oxide atoms in the formula (including any chloride, fluoride, or sulphide atoms which may be present), and D the specific gravity; the volume of the unit, V, is represented by $\frac{P}{D}$.

The showing that in related and homologous species

hardness and chemical indifference are inversely as V; in other words, they increase with the condensation, the relative amount of which in the species compared is shown by the diminution of V.

These principles the author works out in a classification of silicates which is here given in full.

Sozolic Acid; its Chemical, Physiological, and Therapeutical Properties. By Emile Serrant. Paris: Berthier.

New antiseptics are becoming almost as plentiful as were anæsthetics a few years ago, though there is still room for one free from the strong objections which may be urged against phenol, salicylic acid, boric acid, &c. The substance here brought before us is more strictly named orthoxyphenyl-sulphurous acid. In composition it is parallel to salicylic acid, containing, however, the group sulphuryl (SO_2) in place of the carbonyl (CO) of salicylic acid.

It is described as a reddish syrupy liquid, of sp. gr. 1·40, and having a slight odour, peculiar but not disagreeable. It dissolves in water in all proportions, congeals at 8°, and distils at 130°. With ferric chloride it gives the same violet colouration as does salicylic acid. Though a decided acid, it has not the corrosive action of phenol. It is said to arrest absolutely every fermentation, diastatic or fungoid. It is said to arrest all putrefactive changes in urine, animal refuse, sewage, the contents of cesspools to a much greater degree than do phenol, salicylic acid, &c., whilst its perfect solubility in water, its freedom from corrosive properties and from offensive odour render its employment much more convenient.

If its price permits it will doubtless meet with very extended applications.

Report on Experiments made to Test the Germination and Growth of Farm Seeds, in Mixtures of Garden Soil and Basic Cinder, from the North-eastern Steel Company, Limited. By Dr. Munro, F.C.S. Middlesbrough: W. H. Burnett. 1836.

In the first part of this report Dr. Munro argues the question whether or not the presence of the protoxide of iron in the basic cinder is inimical to plant-life, as has been stated by some persons, and he concludes from his experiments that it does not interfere with the growth of plants, even when a very large proportion is present. In fact, the author found that the heaviest dressings of cinder in the 1884 and 1885 experiments—viz., 1 and 2 tons per acre—were productive of nothing but benefit.

The recent experiments were conducted in the following manner; mixtures of garden soil and basic cinder were made as sbown:—

1. Pure basic cinder.
2. 50 per cent cinder and 50 per cent garden soil.
3. 25 „ „ 75 „ „
4. 10 „ „ 90 „ „
5. Garden soil alone.

And in pots containing each 1 lb. of these prepared soils barley, turnips, clover, mustard, and cress were sown with the following results:—The barley germinated in all the pots, but the best was in the mixture of equal parts of soil and cinder; the turnips grew in all the pots, but those in the pure cinder did not survive long; clover germinated in all, but those in the pot of equal parts of soil and cinder grew for a short time only; the mustard did best in the pure garden soil, and did not germinate in the pure cinder; the cress germinated freely in all the pots,—that in the pure cinder, however, was the poorest.

From these experiments the author concludes that seeds will develop in pure basic cinder until the store of nourishment in the seed itself is used up, but, as there is absolutely no organic matter present in the cinder to furnish nitrogenous food, the growth cannot proceed further.

Roughly speaking, two-thirds of all the seeds sown in garden soil alone germinated, and one-half of all those sown in the mixtures germinated also; but more accurate conclusions cannot be given without having recourse to experiment on a much larger scale.

Report of the Port of London Sanitary Committee, with the Half-yearly Report of the Medical Officer of Health for the Port of London to June 30th, 1886.

The Report deals principally with the detection of infectious diseases on board ships arriving at London, and of the means adopted to prevent the spread of such diseases. In the Introduction we find a paragraph the first part of which appears rather startling, viz., "Your officers have been greatly assisted by the continued presence of cholera on the Continent, which undoubtedly at the present time is, as it has been in the past, one of the greatest incentives to sanitary work in this country."

The subjects of inspection and report are—the Docks and River, Smallpox, Cholera, Unsound Meat, Infected Clothing, &c.; and in the Appendix are given Tables of comparison, such as the numbers of ships inspected, cases of disease found, and other information.

Taken altogether, the health of the Port of London and the sanitary precautions taken seem to be very satisfactory, when we consider the large number of vessels constantly arriving from all parts of the world, in some of which sanitation is almost unknown.

CORRESPONDENCE.

THE INTRA-ELEMENTAL FORCES.

To the Editor of the Chemical News.

Sir,—In a recent Address before the Chemical Section of the British Association, Mr. Wm. Crookes, the President, chose for his subject a consideration of the nature of our elements and their probable genesis, as well as the prospects of our dissociating them at some future time. Mr. Crookes, in an eloquent and masterly manner, called attention to the fact that our science of Chemistry rests uneasily at present concerning these so-called elements, and that it more and more loudly demands the breaking down of the barrier they present, and investigation of their composition.

I notice, however, that nothing at all was said about the specific heat of the elements, and, as it appears to me that just from this side the problem of their nature can be attacked with greater hope of success than from any other, presents, so to speak, a handle, I venture to state my ideas briefly.

Our ordinary chemical compounds have the peculiarity that their molecular heats are equal to the sum of the atomic heats of their component elements. In other words, by chemical combination the heat capacity of matter remains unchanged. Whether we take 64 grms. of a mechanical mixture of K+K+S or of the chemical compound K_2S, the heat capacity is the same. This is a characteristic of our force of chemical affinity in its action.

Looking now at the elements, we see at once how entirely different their mode of composition must be from that of our chemical compounds. The metals have all of them an atomic heat of about 6·4. That enormously heavy atom uranium has the same atomic heat as light lithium, and yet there is thirty-five times as much matter in it. Surely the component parts of uranium are united by a force acting in totally different manner from our chemical affinity, and, we may add, probably with a far superior energy. The particles of matter are by it brought so near together that the amplitudes of vibration of our heat-waves are too great to enter into their labyrinth.

Certain it is, finally, that with the decomposition of any one of our elements, answering the law of Dulong and Petit in respect of heat capacity, we will have at hand the key to an unknown land, the arena of unknown forces, beyond the surface of the element, where undoubtedly all is darkness and dead silence, and where there is neither heat nor cold, summer nor winter.—I am, &c.,

CHARLES LUEDEKING, Ph.D.

St. Louis, October, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 17, October 26, 1886.

Researches on the Decomposition of Ammonium Bicarbonate by Water, and on the Diffusion of its Components through the Atmosphere.— MM. Berthelot and André.—In nature it is generally in presence of water that ammonia and carbonic acid react upon each other in the soil, in the sea, or in the atmosphere. Experiment shows that calculations based upon the gaseous exchanges produced in the absence of a body capable of uniting with ammonia cannot be applied to the diffusion of ammonia, passing from water to air in presence of an excess of carbonic acid. The speed of the diffusion of pure ammonia is likewise very different from that of ammonia associated with carbonic acid. In presence of an excess of carbonic acid the transfer of ammonia through the atmosphere and into an aqueous liquid ensues according to laws very different from those of the transfer of ammonia in presence of an inert gas. Whilst this latter is regulated by the tension of aqueous solutions of ammonia, on the contrary, the transfer in presence of carbonic acid does not depend, at least as regards its main portion, on the tension of the total ammonia of the salt, but it depends chiefly on the comparative tension of the carbonic acid in the liquids and in the atmosphere. In a word it is the diffusion of carbonic acid which regulates the decomposition of ammonium bicarbonate by water, and consequently the transfer of ammonia.

Re-composition of White Light by the Aid of the Colours of the Spectrum.—M. Stroumbo.—The author proceeds as follows:—A spectrum is produced and projected in the ordinary manner upon a white screen by means of a prism. But care is taken to mount the prism upon an axle paralled to its edges so that it may receive a rapid rotatory movement. When the rotation is slow the seven colours are seen displacing each other upon the screen, but when the movement is rapid the colours disappear and the space swept by the movable spectrum appears like a band of white light. It is well to note that one of these extremities always remains coloured and terminates in a small stripe of pure red. This fact depends on the minimum of deviation.

Phenomena produced during the Heating and Cooling of Cast-Steel.—M. Osmond.—As the proportion of carbon increases the temperature of the transformation of iron falls. The rapidity of heating has no sensible influence on the position of the critical points. The critical points lower on cooling as this becomes more rapid. The critical points sink a little on raising the initial temperature, on setting out from which the steel is left to cool.

Saturation of Normal Arsenic Acid by Baryta-Water.—Ch. Blarez.—The heats liberated by the successive additions of mols. of baryta-water are 14, 13·5, 15·5, 0·25 and 0·50 cals. The thermic phenomena observed are not the same as those observed on neutralising the same acid with alkalies or with calcium and strontian. The indicators, cochineal and helianthine, change colour when the saturation of the first third of the acid has been slightly exceeded. Phenolphthalein, on the contrary, reddens when two-thirds of the acid have been very exactly neutralised.

Certain Bases of the Piperidic Series.—A. Ladenburg.—The author has obtained the following bases by the transformation of pyridic bases:—Piperidine, α-methyl-piperidine (α-pipecoline), β-methyl-piperidine (β-pipecoline), αα'-dimethyl-piperidine (*αα'-lupetidine*), αγ-dimethyl-piperidine (or αγ-lupetidine), α-ethyl-piperidine, γ-ethyl-piperidine, α-isopropyl-piperidine, and γ-isopropyl-piperidine.

Bulletin de la Société Chimique de Paris. Vol. xlvi., No. 4, August 20, 1886.

Electrolysis of Coke in Ammonia.—A. Millot.—The alcoholic solution described in the author's papers (*Comptes Rendus*, August 10th, 1885, and March 15th, 1880) contains the derivatives of that substance ordinarily obtained by the action of heat, such as ammelide, biuret, and guanidine.

Action of Zinc Powder upon Benzyl Chloride.—E. Prost.—In this reaction large quantites of hydrochloric acid are evolved, and there remains a viscid mass from which the author has isolated three liquids passing over respectively at 105° to 115°, 140° to 160°, and 260° to 280°. In the latter the existence of toluene and phenyl-tolyl-methane, was established, as well as of a small portion of benzyl chloride which had escaped the action of the zinc.

MISCELLANEOUS.

Society of Arts.—The first meeting of the One Hundred and Thirty-third Session of the Society of Arts will be held on Wednesday, the 17th November, when the opening address will be delivered by Captain Douglas Galton, C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following are the probable arrangements for these meetings:—Nov. 24, Wm. Anderson, M.Inst. C.E.; "Purification of Water by Agitation with Iron and Sand Filtration." Dec. 1, adjourned discussion on the paper by Dr. C. Meymott Tidy, on "Sewage Disposal" (read April 14, 1886). Dec. 8, Major-Gen. C. E. Webber, R.E., C.B., "Glow Lamps, their Use and Manufacture." Dec. 15, J. B. Marsh, "Cameo-cutting as an Occupation." There will be five courses of Cantor Lectures during the Session:—(1.) "Principles and Practice of Ornamental Design," by Lewis Foreman Day. (2.) "Diseases of Plants, with Special Reference to Agriculture and Forestry," by T. L. W. Thudichum, M.D. (3.) "Building Materials," by W. Y. Dent, F.C.S., F.I.C. (4.) "Machines for Testing Materials, especially Iron and Steel," by Prof. W. C. Unwin. (5.) "The Structure of Textile Fibres," by Dr. Frederick H. Bowman, F.L.S., F.G.S. Two Juvenile Lectures on "Soap Bubbles," by A. W. Reinold, F.R.S., will be given on Wednesday evenings, Jan. 5 and 12, 1887. The meetings of the Colonial Section and of the Indian Section will not commence till after Christmas.

MEETINGS FOR THE WEEK.

THURSDAY, 18th.—Chemical, 8. "A Spectroscopic Study of Dyes and Colours." "Note on Nægeli's Theory of Fermentation," by Prof. W. N. Hartley, F.R.S. "On the Reduction of Nitrites to Hydroxamine, by Hydrogen Sulphide," by Dr. Divers and T. Haga. "On the Preparation and Saponification of Hydrocyanides of the Diketones," by Dr. Japp and N. H. J. Miller, Ph.D.

THE CHEMICAL NEWS.

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THE PRODUCTION OF SOFT STEEL IN A NEW TYPE OF FIXED CONVERTER.*

By GEORGE HATTON, Bilston.

The development of the manufacture of steel has, until recently, been almost entirely in the direction of large outputs, entailing increasingly large and costly plants; consequently the revolution from iron in favour of steel has been very severely felt by iron manufacturers, inasmuch as their existing works and plant have not been adaptable to the new order of things.

Some method of making soft steel of the highest quality, in moderate, but, at the same time, rapid and continuous quantities, and with comparatively inexpensive plant, has, therefore, long been desirable, and for this purpose, the Fixed Converter offers many advantages. The Fixed Converter is not a new invention: Sir Henry Bessemer conducted his early experiments in one, and it has been used somewhat extensively in Sweden, for many years, making steel of very high quality.

In using the old type of fixed converter, a great difficulty experienced has been the necessity for keeping the full pressure of blast on during the tapping out of the metal after the process of conversion was completed, with the risk of more or less oxidation of the bath of metal which oxidation would, of necessity, be continued till the last of the steel ran from the converter, owing to tuyeres being fixed on a level with the converter bottom.

M. Wittnöfft, of Bochum, Westphalia, in a paper read before the Cleveland Institute of Engineers, proposed, as a remedy for this undesirable after-blow, the employment of an auxiliary blast engine of considerably smaller dimensions than the engine used in blowing the charge, but which could be made to maintain the full pressure of blast, but with reduced volume. This smaller engine was to be started at the completion of the blow, and, at the moment of tapping the converter, the large engine being stopped, or the blast from it shut off, as soon as the smaller one was in motion. Whether this suggestion was ever put into practice or not I am unable to say.

The Clapp and Griffiths converter (a South Wales invention) was specially intended to meet this difficulty, by stopping up the tuyeres at the termination of the blow, and thus preventing further oxidation of the bath; the risk of oxidation being further minimised by fixing the tuyeres in a position about half-way between the converter bottom and the surface of the metal, so that, by the time about half the metal had left the converter, the tuyeres were free and oxidation was at an end.

The essential feature of this converter was a very ingenious arrangement for actuating the stoppers to the tuyeres. It consisted of two pistons, of unequal areas, attached to the spindle or rod carrying the stopper. The smaller piston was under the pressure of the blast during the operation of blowing, and served the purpose of holding back the stopper from the tuyere; the larger piston during that time being under atmospheric pressure only, but on the admission of the blast behind the larger piston at the end of the blow, which was done by simply opening a hand cock, the pressure on the larger area overcame the pressure on the smaller area, and the stopper was at once driven against the back of the tuyere, closing it with the exception of a very small hole provided through the centre of the stopper which was necessary to admit sufficient blast to keep the metal from coming back through the tuyere.

A Clapp and Griffiths converter was erected and started at the writer's works at Bilston, early in 1884, but several practical difficulties were met with, due to the construction of the converter. The position of the differential piston and stopper appliance, immediately behind the tuyere, and on a lower level than the metal line (a position of danger), was very objectionable, owing to the delay in, and costliness of, replacing them if damaged. The exposure of the back end of the tuyere, and of a large area of lining material, to the full pressure of blast in the blast box, added considerably to this danger, it being difficult to keep the lining tight, the blast having a tendency to penetrate the joints and produce outbreaks of metal into the blast box. These faults, and the general inaccessibility and immovable character of the converter lining and bottom, causing great difficulty and delay when repairs were needed, led the writer, after a short experience, to design a fixed converter upon entirely different lines, with a view to overcoming these difficulties.

A sectional elevation of this new converter is exhibited, from which its general construction will be readily understood. The whole is rigidly supported on four strong cast iron columns, add for convenience of construction is attached to them by the blast chambers, G, which form part of the middle section of the converter shell. The lower section, C, is readily detachable, and is secured in position by cotter bolts passing through the flanges, D and E, or by other suitable means. This lower section is made sufficiently deep to enable the portion of the lining liable to the greatest wear, together with the tuyeres, to be removed with it, so that, by simply changing a lower section, in a very short space of time a converter can be completely renovated, and in this way can be kept at work night and day, almost continuously. The lining of the middle and lower sections consists principally of ganister, rammed hard, according to the usual method of lining Bessemer converters.

It has been found more convenient to line the nose, or upper section, with silica bricks, and a course of silica bricks is used at A as a support to the ganister lining of the middle section, making it safe and independent when the lower section is removed.

The tuyeres are of fire-brick, and preferably of square outer section, with a single round taper hole through the centre of each, 1¼ in. diameter at the inner end. These tuyeres are so placed as to be about 6 in. below the surface of the molten metal, and about 10 in. above the bottom. The bottom of the lower section is made with silica bricks, set in ganister, upon a bed of loam sand. One or more duplicate lower sections are provided, and as they are removed, with their linings worn out, they are repaired and placed in a stove to dry and keep warm till wanted.

The method of changing a lower section is simple; a bogie running on rails is placed under the centre of the converter, a hydraulic ram—which is actuated by a pair of manual pumps fixed any convenient distance away—then passes up through the centre of the bogie, taking the weight of the lower section, and after the cotters are removed from the bolts and the tuyere pipes disconnected, gently lowers it on to the bogie, by which means it is then removed to the repairing shed. The new lower section can now be brought into position under the centre of the converter, and raised by the ram and cottared to the middle section, the joint being made with a little plastic ganister, placed on the edge of the lower section, just before raising it into position. When the converter is blowing, the hydraulic ram is at rest, and entirely below the floor level, covered with a plate, and further protected by a bed of sand, some ten or twelve inches thick, from any possible damage from hot steel or cinder.

The blast connections to the tuyeres are so arranged that no costly valves or blast-boxes are exposed to danger behind or on a level with the tuyeres, the blast being

* Read before the British Association, Birmingham Meeting, Section B.

conveyed separately and directly from the blast-chamber, G, to the centre of each tuyere, passing through the valve, H, and down the cast-iron pipe, J, which latter has a ball and socket connection to the valve, and is held in position by a bridle, L, and set-pin, M. The lower end of the pipe at N is faced and bolted to the cast-iron tuyere block, O, which is also faced at N, and at this point a thin asbestos mill-board ring forms an air-tight joint.

When changing a lower section it is not necessary to remove the connecting pipes. They are unbolted at N, the set pins in the bridles are slackened, the pipes then swing back into an oblique position, and are there held by the bridles by re-tightening the set pins, and in this position are out of the way of the lower section.

The valves, H, are of the ordinary baffler type, are all connected together by levers, and can all be closed or opened by the movement of one handle.

Each valve has a hole ¾ inch diameter, through which sufficient blast passes while the valve is closed to support the weight of metal in the converter, and keep it out of the tuyeres during the process of tapping. The nose of the converter is accessible from an upper platform, and a movable spout is provided for the purpose of charging scrap during the blow.

The charge is run direct from a cupola, and consists of about 46 cwt. of hæmatite iron, the blast being put on at the converter at the moment the cupola is tapped. The blow usually lasts about fifteen to eighteen minutes, and just as the carbon blow is commencing, most of the silicon being by then eliminated, a greater portion of the slag is allowed to boil out at the slag-hole provided at S; this lasts about one to two minutes, when the hole is stopped up for the remainder of the blow. The charge is blown right down,—that is, till the carbon flame has disappeared,—when the signal is given to tap out; at this moment the valves are closed, and the steel instantly begins to run from the tapping spout. Ferro-manganese, finely crushed, is added in the ladle while the steel is running from the converter, in about the proportion of 20 lbs. per ton (for 80 per cent manganese). The quantity of steel produced per blow is about 2 tons.

The pressure of blast used may be from 5 to 8 lbs. per square inch; in no case need it ever exceed about half that required in the ordinary Bessemer process, or say 10 lbs. as a maximum.

The rapidity with which the converter can be worked depends very much upon the facilities at hand for dealing with the steel produced.

At the writer's works, twenty blows per shift of twelve hours have been done, but, with more efficient casting-pit arrangements, this output could be very considerably increased.

The usual numbers of Bessemer hæmatite pig iron are used, the percentage of silicon preferred in the mixture being about 1¾ to 2 per cent. When working rapidly, with surplus heat, a considerable quantity of scrap is added through the nose during the blow.

The steel produced by this process is of the highest quality, remarkably soft, and particularly adapted for welding, it being largely in demand for lap-welded boiler tubes and other similar purposes; it is also made into boiler plates, and is largely made into stamping sheets and tin plates for difficult work. Samples of it are to be seen at the Bingley Hall Exhibition.

The carbon is exceedingly low, averaging from 0·05 to 0·10 per cent, and seldom exceeding 0·15 per cent.

The silicon seems to be more thoroughly removed than in the Bessemer process, which is a great advantage, and is probably due to the less acid character of the slag at the end of the blow, resulting from the removal of the greater portion of the silicious slag at the end of the silicon blow as already described, the following being the analysis of the slag at the termination of the blow:—

FeO.	SiO_2.	MnO.	Al_2O_3.
41·90	46·22	6·97	4·89

The tensile strength of the steel is about 24 to 26 tons per square inch, with elongations averaging 25 per cent. Some analyses are as follows:—

C.	Si.	S.	P.	Mn.
0·04	trace	0·07	0·06	0·30
0·07	0·009	0·02	0·05	0·37
trace	0·008	0·05	—	0·30

The advantage claimed for the process over the ordinary Bessemer process, apart from the question of cost of outlay, is that a better quality is produced—one that is uniformly softer and more reliable; the reason for this being that the action in the converter is less violent. The charge can always be blown right down, with less risk of oxidation, owing to the fact that the final changes take place less rapidly: this is due to the low pressure of the blast, and to the fact that instead of the whole charge being constantly penetrated and oxidised by direct contact with the blast, as is the case in the ordinary bottom-blown Bessemer converter, only about a third of the charge is subject to direct oxidation at any one time, a further indirect process of oxidation at the same time being carried on by circulation and admixture of the oxidised iron with the remaining portion of the bath.

Further, by tapping the steel from the bottom of the charge, all risk of taking up particles of partially converted metal, which may adhere in and around the nose, and contain more or less silicon, is avoided, as is also all unnecessary contact with slag, which remains on the top of the bath, and only runs from the converter after the steel is in the ladle.

Some advantages of this process, compared with the Siemens process, are that—where only a moderate output of steel is required—the constant and regular production of ingots enables soaking pits to be economically used, instead of the more costly method of heating in furnaces. Also, softer material (lower in carbon) can be made with regularity and certainty; also, Welsh or other hæmatites made from Spanish ore, containing a larger percentage of manganese than West Coast brands, can be used with great advantage,—in fact, are preferred,—and when not used alone are almost always used as a mixture with West Coast iron.

This converter is well adapted for making steel castings. Though the plant at the writer's works has not been designed with that view, castings, weighing from a few pounds to upwards of one ton each, have been repeatedly made, and always with success. The following are analyses of some of them, which, though rather variable, the castings were all sound and satisfactory:—

C.	Si.	S.	Mn.
0·16	0·113	—	0·18
0·50	0·30	0·027	0·99
0·42	0·046	0·04	0·46
0·66	—	—	0·50
0·28	0·181	—	—

ON THE DETERMINATION OF ALUMINIUM IN PRESENCE OF LARGE PROPORTIONS OF IRON.

By ROBERT T. THOMSON.

Having lately had occasion to test for and determine a minute proportion of aluminium in presence of a large proportion of iron, I was led to try the capabilities of the two best-known methods, namely, by boiling with a large excess of caustic soda or potash and subsequent precipitation in the filtrate from the peroxide of iron, and by direct precipitation with thiosulphate of sodium. In the latter case only about 90 per cent of the total aluminium present was obtained, when working on a solution containing 100 parts of iron to 1 part of aluminium. But

the failure of the caustic alkali method was more striking, as not a trace of alumina could be detected in the soda filtrate. The solution operated upon contained 2 grms. of iron and 0·02 grm. of aluminium. It was nearly neutralised, and slowly added to a quantity of caustic soda solution heated to boiling in a nickel basin. The mixture was thoroughly boiled, filtered, and tested for alumina, with a negative result, as already stated. The excess of caustic soda used was more than 10 grms. Both of these processes had to be rejected, but I at last hit upon the following method, which gives excellent results :—

The iron, if in the ferric state, is first reduced to the ferrous condition by passing a current of sulphurous acid through the solution. The excess of sulphurous acid is boiled off, the mixture cooled, and at least as much phosphoric acid, or phosphate of ammonium or sodium, added as will be equivalent to the alumina present. It is advisable to use a large excess of phosphoric acid, as the alumina may not be completely precipitated if it has not at least its own equivalent of the former. One drawback to the unlimited use of phosphoric acid is that if manganese is present it will be thrown down, but if the quantity of the former is limited the latter will remain in solution. Where manganese is present in quantity it is advisable to employ the alternative method of precipitation to be described further on. Ammonia is now added until a faint permanent cloudiness is formed; then excess of ammonium acetate, which throws down the alumina as phosphate. The precipitate always contains some ferric phosphate, which forms from any traces of ferric iron salt which may have escaped reduction, and from the oxidising action of the air during filtration. The great bulk of the iron, however, remains in solution in the ferrous condition. The precipitate is now collected on a filter, washed two or three times with water, and dissolved by passing dilute warm hydrochloric acid through the filter. If it does not seem sufficiently free from iron, the solution thus obtained should be put through the same process as has been just described, beginning at reduction with sulphurous acid. When filtered rapidly I have had as little as 0·1 grm. of peroxide of iron in the aluminium phosphate, and in no case have I required a re-precipitation. It is well to reduce the iron as much as possible.

An alternative method of getting rid of the great proportion of the iron is to add ammonia to the reduced solution till a slight cloudiness is formed; then excess of ammonium acetate, and boil for a few seconds. The whole of the alumina and a portion of the iron are precipitated, and are collected on a filter. No phosphoric acid is added in this case, and manganese remains in solution. More iron is brought down than in the first-described cold method, and, when only minute quantities of alumina are expected, a second reduction and precipitation will most likely be necessary.

After obtaining a satisfactory precipitate (whichever method has been adopted) it is dissolved in hydrochloric acid, boiled with a little nitric acid to oxidise any proto-salt of iron, nearly neutralised with pure caustic soda, and added to a considerable excess of the latter in a nickel basin. The mixture is boiled for a short time, filtered, the filtrate acidified with hydrochloric acid, and a large excess of phosphoric acid or phosphate of ammonia or soda added. I have found that the presence of at least two equivalents of P_2O_5 to one of Al_2O_3 are necessary to give rise to the normal phosphate of aluminium ($Al_2P_2O_8$). The latter is now precipitated by adding ammonia till a slight cloudiness is produced, and then excess of acetate of ammonium. Or the precipitation may be effected by simple neutralisation with dilute ammonia till a red reaction ceases to be obtained with blue lakmoid paper. The aluminium phosphate is now collected on a filter, washed thoroughly with a hot 1 per cent solution of ammonium nitrate, containing about 0·1 grm. of the di-acid ammonium phosphate ($NH_4H_2PO_4$) per litre, dried, ignited, and weighed. If the aluminium phosphate is washed with water it partially loses its gelatinous form, and becomes tedious to filter. But besides this the precipitate is decomposed to a considerable extent, and a portion of the phosphoric acid passes into solution. For these reasons the precipitate must be washed in the manner described, when pure $Al_2P_2O_8$ is weighed, and may be calculated to alumina or aluminium as required.

The following are results obtained by the above process in solutions containing 3 grms. of metallic iron. To the iron solution a weighed quantity of pure ammonia alum was added.

Grm. of Al_2O_3 added.	Grm. of $Al_2P_2O_8$ = obtained.	Grm of Al_2O_3 obtained.
0·0340	0·0800	0·0336
0·1135	0·2695	0·1132
0·1135	0·2703	0·1136

The presence of titanium is not injurious in the above process, as only slight traces of titanic acid are dissolved by strong caustic soda.

City Analyst's Laboratory, Glasgow.

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 244.)

6. *Attacking and Dissolution of Minerals.*

To dissolve the powdered mineral we make use of fuming hydrofluoric acid (2 or 3 c.grms. of acid to 0·5 m.grm. of material) or fluoride of ammonium combined with hydrochloric acid. It is necessary to make sure that the hydrofluoric acid is quite free from sodium, calcium, and aluminium, by evaporating to dryness 1 c.c. of the commercial acid with several centigrammes of sulphuric acid, and then making an analysis of the residue. Even if the acid is impure it can still be very well used for preparing fluoride of ammonium. Commercial hydrofluoric acid always leaves a slight residue when evaporated to dryness, even when it contains no salt in solution: this residue, which is of a brown colour, is carbonised by the addition of sulphuric acid; it comes from the fact that the acid is always kept in gutta-percha bottles.

If this residue, which under the microscope appears as little brownish black flakes, interferes too much, we can use instead the mixture of fluoride of ammonium and hydrochloric acid. The action of this mixture is not so energetic as that of fuming hydrofluoric acid, and we must be careful, when trying for potassium, to increase the temperature to a red heat after the evaporation.

The same difficulties occur when we try to keep a stock of these reagents. We can only use platinum or gutta-percha bottles for this purpose, and gutta-percha bottles large enough to carry any considerable quantity are very awkward to manipulate when we only require a few centigrammes of the acid. The most convenient form of flask is about 30 c.c. capacity: in the stopper is fixed a little gutta-percha or platinum wire, twisted into the form of a corkscrew; this screw is about 3 m.m. in diameter, and serves as a sort of pipette. It is not easy to procure these bottles, and even less easy to make them in the laboratory. We can make gutta-percha receptacles for keeping fluoride of ammonium by taking a lump of gutta-percha which has been softened in warm water, and squeezing it in between two porcelain crucibles of the shape we require. The porcelain crucibles must be oiled first to prevent the gutta-percha from sticking to them. The lid is formed in the same manner, between two porcelain lids, one of which has had the handle broken off. The best way of conducting the attack with hydrofluoric acid is in a hemispherical cup of platinum about 1 c.m. diameter, such as are used for blowpipe experiments.

To clean these platinum cups we must make a mould

of box wood; or we can make one quite as effectively with plaster-of-paris and a solution of lacquer in alcohol.

These moulds serve as supports, and enable us to clean the cup thoroughly without any risk of damaging them

Concave dishes for sublimation can be made by hammering thin plates of platinum which have been heated to redness until they take the required form. It will be found most convenient to use a piece of lead as an anvil, and a hammer similar to those used for making cupels.

When we have to deal with a silicate we commence by placing a few drops of hydrofluoric acid, or fluoride of ammonium and hydrochloric acid, into the crucible; then we add the powdered mineral. We evaporate at a moderate heat, and if necessary we add a little more of the reagent and evaporate afresh. In this operation, as well as in those which will be described later on, great care must be taken with regard to the hydrofluoric acid fumes, as a very small quantity may cause severe results if in contact with any wound.

To the dry residue, which consists of fluorides, we add sulphuric acid, diluted so that abundant vapours of concentrated acid are given off after a prolonged evaporation. This operation must be performed with great care, so that there remains no fluosilicate or fluoaluminate unattacked. It is as well not to drive off all the sulphuric acid; a slight excess helps the solution of the salts in water, and sometimes it even aids the formation of crystals; it also prevents the inconvenient drying up of drops during the microscopical examination.*

Thus in cases of necessity we have to add a little sulphuric acid and re-evaporate, until the vapours commence to come off, before proceeding to dissolve in boiling water. Then we fill the cup half full of water, and evaporate the contents by boiling gently until there remains only about 1 c.grm. of the solution for every 0·1 m.grm. of mineral.

7. *Test for Calcium.*

The solution of sulphates must be introduced into a capillary tube about 2 m.m. diameter, which serves as a pipette. By blowing cautiously in the end of the tube we can manage to get on a glass plate several drops of about 2 or 3 m.m. diameter. The capillary tube enables us to divide the material under examination into several portions, even when it does not weigh more than 0·1 grm. We can also keep prepared solutions therein for an indefinite period.† The glass plate carrying the drops is placed, without any cover, under a microscope magnifying about 150 or 200 times. I prefer working without a cover, and I protect the object-glass by means of a thin plate of mica fixed with a little glycerin, because the evaporation of the drop has sometimes been of very great service, and the action of the reagents is much more rapid and even than when a cover is used.

If the mineral contains a sensible quantity of calcium we see, either at once or after the lapse of two or three minutes, crystals of gypsum of the well-known form, ∞P, P, ∞P, ∞. If the quantity of calcium is considerable the field of observation is filled with short rudimentary prisms, characteristic of gypsum: between these crystals fine needles are formed, often grouping themselves together in irregular rosettes. The transverse measurement of these crystals is still smaller when the solution contains much hydrochloric acid.

Later on we see larger crystals appear on the margin of the drop, whose angles we are able to measure, and amongst which we sometimes find twin lance-heads. The gypsum crystals are generally about 60 microns in length and 6 microns wide.

It is only very rarely necessary to hasten the crystallisation. Place the plate for a few minutes in a cardboard box, which has been wetted with alcohol. The crystals obtained in this manner resemble those formed in a hydrochloric acid solution after the addition of sulphuric acid.

In the greater number of cases we can get very fair results by evaporation only; I once obtained crystals, after waiting some time, and without the aid of alcohol, from a solution containing only 0·3 per thousand parts of lime.

The sensitiveness of this reaction is quite sufficient; in fact, it is possible to detect the presence of 0·0005 m.grm. of lime. This sensitiveness is quadrupled by the aid of alcohol; but, as I have already remarked, it is at the expense of size and sharpness of form of the crystals.

Experiments with the more common reagents, such as ammonium oxalate, oxalic acid, and ammonium carbonate, are not satisfactory. The crystals of the oxalate and carbonate are too confused and small, unless we are willing to devote a very much longer time to the experiment.

(To be continued.)

* If we want to keep any specimens for some time, we can prevent evaporation by adding a little glycerin and covering it over. If the evaporation has been carried too far, we can remedy it by breathing gently on the dried mass, or by adding a small drop of water with a platinum hook.

† If we leave a capillary tube in a vertical position for several hours the solution becomes perfectly clear.

TESTING ANALYSTS.

REACTIONS useful in the examination of some novel substance, natural or artificial, are often wanted and often found. But never till lately did we hear of a proposed test for analysts. Unfortunately the rationality of the proposal is by no means on a par with its novelty. As we learn from the *Times* of the 10th inst., Councillor Taylor, of Bedford, who is, forsooth, a member of the "Food and Drugs Committee," made a statement which the leading journal rightly calls "extraordinary." He is reported to have said that during the month six samples of beer had been sent to Guy's Hospital for analysis, and he, in the presence of a chemist, saw placed in one of the samples a large quantity of a most deadly poison. "This," said Mr. Taylor, "was done because he considered that not only should the analyst test their drugs, but the analyst ought himself to be tested." The report upon this sample was as follows:—"I am of opinion that the sample of beer is genuine."

Now we have no right to say that this "test" was purposely concocted to bring the analyst concerned and analytical chemistry in general into disrepute. But if it was an honest *bona fide* attempt on the part of Councillor Taylor to try the trustworthiness of the analyst, it shows a lamentable want of judgment and of common sense An analyst, on receipt of a sample, does not proceed to examine it for every known substance. Were he required to do so the fee which he would necessarily have to demand would, perhaps, astonish the Bedford Food and Drugs Committee. As the matter is ably put by Dr. W. H. Corfield in the *Times* for the 11th inst:—"When a sample of food is sent to a public analyst for analysis it is presumed by him to have been bought in the ordinary course of trade, and he, therefore, only examines it for substances which his experience teaches him are to be found in adulterated samples of that kind of food."

Further, according to all accepted definitions of adulteration, the beer, though poisoned, was yet "genuine." By adulteration is understood, not the addition to saleable articles of any substance whatever, but the addition of foreign matter in order to increase quantity, to render the quality seemingly better than it really is, to mask defects, &c. The addition of a "most deadly poison" which answers none of these purposes, is not "adulteration," but a totally distinct and a much more serious crime.

We do not know whether municipal officials are acting within their legal competence in tampering with samples taken for analysis,—a point upon which we should recommend the Society of Public Analysts to obtain an authoritative opinion. But we submit that a safer and a more rational method of "testing the analyst" would

known to be used, or at least to have been used, in the sophistication of malt liquors, and see whether chemical analysis be able to detect the fraud.

Since writing the above remarks we have met with three letters upon the subject in the *Times* of the 15th instant, which demand notice. The first of these communications, signed by Messrs. Bernard Dyer and Otto Hehner on behalf of the Society of Public Analysts, takes the same view as that of Dr. Corfield and our own,—namely, that a Public Analyst in his official capacity is merely bound to search for substances added for the purposes of sophistication, and not for the detection of "deliberate attempts at poisoning." From this letter, and from the concluding sentence of the one by the Public Analyst for Bedford, we judge that Mr. Taylor's "ridiculous trick" is a violation of directions laid down in the statute. Whether persons tampering with samples taken incur any legal penalty it is not our province to decide.

The town-councillor in question writes in an impenitent vein. He thought it part of his duty to see that the ratepayers "were really having the thorough analysis for which they are called upon to pay at the rate of a guinea per sample." Now the analysis which a Public Analyst is called upon to perform merely extends to the detection of such adulterants as are known to be in use. He admits that "an analyst would not be expected to test for anything foreign in the adulteration of the article," but he seeks to evade this point by adding that "he" (doubtless his confederate in the trick) "had the fairness to select a poison *well known in the adulteration of beer*." These last words are painfully ambiguous. Does Mr. W. E. Taylor mean to say "well known to be at present used in the adulteration of beer"? Numbers of poisons have been *alleged* to be used in the adulteration of beer without satisfactory evidence. If the analyst has to search for the whole number his "guinea" will be indeed hard-earned.

The Public Analyst for Bedford writes that one of his assistants was apparently made ill by tasting the samples. He informs us, further, that the Town Clerk of Bedford has so far not complied with his urgent request for full particulars.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 4th, 1886.

W. CROOKES, Esq., F.R.S., Vice-President, in the Chair.

MESSRS. H. Crompton, G. Dyson, T. B. Tyson, and S. Williamson were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. James A. Audley, Ladderedge, Stoke-on-Trent; Chichester A. Bell, B.A., 54, Warwick Gardens, Kensington, W.; John Williams Bevan, Southview House, Shirehampton, N. Bristol; William Beecroft Bottomley, 26, Thorngate Road, Paddington; Cuthbert Robert Blackett, Fitzroy, Melbourne; Ebenezer John Cox, 23, Albany Road, Harborne, Birmingham; John Fuller, Rookwood, Chapter Road, Willesden Park; Alexander Galt, 61, Sardinia Place, Hillhead, Glasgow; Thomas Forrest Garvin, Colombo, Ceylon; Henry John Hardy, 163, Edmund Road, Sheffield; Sydney Joseph Harris, Wedgewood Institute, Burslem, Stoke-on-Trent; George Crompton Holt, Green Bank, Lawton, Kidsgrove, Stoke-on-Trent; H. E. Kirby, Kelsey Park, Beckenham, Kent; Henry A. B. Leissner, 8, Loftus Street, Sydney, N. S. Hugh O'Donaghue Macan, B A., Park Villa, St. Leonard's Road, Exeter; James B. L. Mackay, Trinity College, Melbourne; James B. Mackintosh, School of Mines, New York; Edward Lloyd Marks, Melbourne; Mu N. A. F. Moos, Poona, India; Herbert Pilkington, Tipton Green Furnaces, Tipton; L. S. M. Pyke, Devonshire Place House, Regent's Park, N.W.; Edwin Guayle, Glebe Point, Sydney; James Schleselman, Dundee; Harry Silvester, Roskhedyn, Broughton, Wrexham; Joseph Stapleton, 3, Lower Sackville Street, Dublin; Alfred Hughes Twining, Salcombe, Knightsbridge, Devon; Arthur Turner, The Limes, Aylesbury; William Walker, Junr., Saltburn-by-the-Sea; Reginald Williams, The Green, Norton, Stockton-on-Tees.

The following papers were read:—

86.* "*The Action of Chlorosulphonic Acid on Naphthalene-α- and β-Sulphonic Acids.*" By HENRY E. ARMSTRONG and W. P. WYNNE, B.Sc.

The investigation recorded in this paper is an extension of that of Armstrong and Graham on the action of sulphuric acid on naphthalene (*Trans.*, 1881, 133; *Ber.*, 1882, 204). The separation of the products of the action of sulphuric acid proving a matter of great difficulty, it was judged expedient to postpone their study until further knowledge of the naphthalenedisulphonic acids had been obtained, and with this end in view such acids have been prepared by reactions in which the possibility of secondary changes taking place, such as readily occur on heating with sulphuric acid, is reduced to a minimum.

When naphthalene and SO_3HCl react in the proportion of molecule to molecule, naphthalene-*α*-sulphonic acid is alone produced; it is therefore only necessary to use double this proportion of chlorosulphonic acid, and the operation becomes equivalent to that of sulphonating the *α*-monosulphonic acid. It is desirable to add a slight excess of SO_3HCl, as some disulphochloride is formed; the naphthalene may be dissolved in CS_2, which is subsequently distilled off on the water-bath, or the chlorosulphonic acid may be added directly to the naphthalene. No higher acid is formed, even when a considerable excess of SO_3HCl is used, at temperatures not exceeding 100°. To isolate the disulphonic acid, the product is neutralised with lead carbonate, and the dried and finely divided lead salt is exhausted with hot spirit; the portion thus extracted is lead naphthalene-*α*-sulphonate; the residue consists of the disulphonate.

The acid thus prepared—no evidence of the presence of isomers has been obtained—differs from the two disulphonic acids of Ebert and Merz; its (sulpho) chloride melts at 184°, and on treatment with PCl_5 yields *γ*-dichloronaphthalene (Armstrong and Graham), so that the acid is probably the $a^1a^{4'}$ modification. It may be termed *γ-naphthalenedisulphonic acid*. The lead, calcium, and barium salts very closely resemble the corresponding salts of Ebert and Merz's *β*-acid, which there is reason to believe is the symmetrical or $\beta^2\beta^{2'}$ modification, dissolving very sluggishly in water, and parting with their water of crystallisation only at a high temperature and slowly. The potassium and sodium salts (each containing 2 mols. Aq.) crystallise well, especially the latter, which forms glistening well-defined plates; although easily soluble in water, they are less soluble than the same salts of Ebert and Merz's *α*-acid.

Naphthalene-? β-disulphonic Acid.—This acid appears to be the sole product of the action of SO_3HCl, on potassium naphthalene-*β* monosulphonate. The chloride is added in the proportion of 3 mols. to 1 mol. of the dry salt, it being advantageous to employ a considerable excess of SO_3HCl in order to obtain a liquid product, and finally heat is applied by means of a water-bath; as a rule it is only necessary to heat during a few minutes to ensure

* Communications 86 to 91 are Nos. 1 to 6 from the Chemical Department of the City and Guilds of London Institute Central Institution, South Kensington.

the whole of the salt being attacked. More or less sulphochloride is formed, the amount depending on the time during which heating takes place. Water is cautiously added to the product, and the acid potassium sulphate which separates after a time is filtered off; the remaining dissolved sulphate is separated by evaporating on the water-bath and adding spirit to the residue.

The *barium* salt, $C_{10}H_6(SO_3)_2BA + 4OH_2$, and the potassium salt, form granular masses very similar to the corresponding β-monosulphonates in appearance and solubility; the sodium salt, $C_{10}H_6(SO_3Na)_2{\cdot}7OH_2$, forms long needles, very soluble in water. The sulphochloride is very soluble in benzene, but crystallises well from a mixture of benzene and shale spirit in aggregates of short prisms, and melts at 128—129°.

87. *The Action of Bromine on (Schaefer's) Betanaphtholsulphonic Acid.*" By HENRY E. ARMSTRONG and F. W. STREATFEILD.

As end product of the action of bromine on

$$C_{10}H_6(OH){\cdot}SO_3K,$$

Armstrong and Graham obtained a yellow salt of the formula $C_{10}H_4BrSO_6K$, and from the manner in which it was produced they were led to regard it as a *bromoxylnaphthaquinonesulphonate*, $C_{10}H_4(O_2)(OBr){\cdot}SO_3K$, rather than as a *naphthaquinonebromohydroxysulphonate*, $C_{10}H_3Br(O_2)(OH){\cdot}SO_3K$; a small quantity of a yellow crystalline body was produced simultaneously but was not examined.

The authors have further studied these products. On adding barium chloride to a boiling solution of the potassium salt, a garnet-red salt crystallised out, which after dehydration contained 29·18 per cent barium, corresponding with the formula $C_{10}H_3BrSO_6BA$; on treatment with acid this is converted into a yellow monobarium salt, $(C_{10}H_4BrSO_6)_2Ba$. The production of these two salts leaves no doubt that the potassium salt is a *naphthaquinonebromohydroxysulphonate*.

The yellow by-product is found to be *dibromohydroxynaphthaquinone*, $C_{10}H_3Br_2(O_2){\cdot}OH$.

The authors have discovered tetrabromonaphthol to be a (third) product of the action of bromine on Schaefer's salt. They find also that it is possible to prepare what appears to be a tribromonaphtholsulphonate by the action of bromine on potassium betanaphtholsulphonate dissolved in boiling muriatic acid. By oxidation of Schaefer's acid they have obtained a sulpho-acid—probably β-sulphophthalic acid: the experiments were made before the publication of those of Graebe and Rée, and it remains to identify the oxidation product with the β-sulpho-acid described by these chemists; the results, however, serve to confirm those of Claus and leave no doubt that Schaefer's acid is a *heteronucleal* di-derivative of naphthalene.

88. "*The Action of Bromine on the Naphthalenesulphonic Acids.*" By HENRY E. ARMSTRONG and W. P. WYNNE, B.Sc.

As a general result of their experiments, the authors conclude that all the *heteronucleal* napthalenesulphonic acids, or heteronucleal naphthalenesulphonic-derivatives, yield as end product, on treatment with bromine, a bromine-derivative of either naphthaquinonesulphonic acid, or of naphthaquinone.

From the potassium salt of Ebert and Merz's β-disulphonic acid they have obtained a salt crystallising in well-defined yellow plates, of the formula

$$C_{10}H_3Br_2(O_2)SO_3K$$

(found K = 8·69, Br = 37·05; theory K = 8·98, Br = 36·87). The α-salt of these chemists yields what appears to be an isomeric dibromonaphthaquinonesulphonate, crystallising in very soluble pale yellow needles (found K = 8·63).

Potassium naphthalene-β-monosulphonate is first converted into the dibromosulphonate described by Jolin; on further treatment this yields what appears to be a tetrabromonaphthalenesulphonate, a brominated quinonesulphonate and tetrabromonaphthaquinone.

The authors' ?-β-disulphonate is first converted into a dibromomonosulphonate isomeric with that prepared from the β-monosulphonate; on further treatment this yields the same product apparently as Jolin's isomeric salt.

Potassium naphthalene-α-monosulphonate is known to yield dibromonaphthalene (m. p. 81°) as chief product on bromination. From their γ-disulphonate the authors have obtained a dibromomonosulphonate, two salts—each of which gives results on analysis indicating that they are dibromoquinonesulphonates, dibromonaphthaquinone, and a substance which appears to be hexabromonaphthalene; these two last are the chief products.

Hence it appears that an α-sulphonic radicle is readily displaced by bromine, but that a β-sulphonic radicle resists displacement (probably) until the nucleus in which it is contained undergoes oxidation.

89. "*α-Nitro-, α-Bromo-, and α-Chloronaphthalene sulphonic Acids.*" By HENRY E. ARMSTRONG and S. WILLIAMSON.

As such different results are obtained on sulphonating naphthalene under various conditions, it appeared desirable to acquire further information regarding the behaviour of naphthalene-deratives towards sulphonating agents.

α-Nitronaphthalenesulphonic acid has been prepared by Clève from nitronaphthalene and fuming sulphuric acid; it corresponds to γ-dichloronaphthalene, and is therefore, in all probability, the $\alpha^1\alpha^{4'}$ modification. The authors find that the same acid may readily be prepared by means or ordinary sulphuric acid, or by the action of SO_3HCl; they have not met with an isomer. The potassium salt is remarkably stable in presence of bromine, and no well-defined product is obtained by heating an aqueous solution with bromine at 100°; but on evaporating the resulting yellow solution a deep purple-red coloured liquid is obtained. On distilling the potassium salt with $K_2Cr_2O_7$ and muriatic acid, a mixture of almost colourless chloronitronaphthalene (m. p. 111°) with a dichloronitronaphlene (m. p. 85°) passes over; a dibromonitronaphthalene is formed on similar treatment with $K_2Cr_2O_7 + HBr$.

When bromonaphthalene is sulphonated by means either of H_2SO_4 or SO_3HCl, it yields together with $\alpha^1\alpha^4$ $C_{10}H_6Br{\cdot}SO_3H$, which is already well known and is the chief product, an isomeric acid, the salts of which are much more soluble than those of the 1 : 4 acid; the chloride of this acid crystallises from benzene in long prisms melting at 151°.

Chloronaphthalene in like manner yields a small amount of an isomer of the 1 : 4 acid when sulphonated by SO_3HCl; the salts of the new acid are easily soluble; its chloride crystallises from a mixture of benzene and shale spirit in clusters of short thick prisms melting at 127°.

1 : 4 Chloronaphthalenesulphonic acid is readily attacked by bromine, and the 1 : 4 bromo-acid by chlorine ($K_2Cr_2O_7$ and HCl), both yielding the 1 : 4 bromochloronaphthalene (m. p. 67°) described by Guareschi.

On treatment with bromine, 1 : 4 bromonaphthalenesulphonic acid is for the most part converted into 1 : 4 dibromonaphthalene (m. p. 81°), but this is not the only bromonaphthalene produced; moreover, a portion is converted into a quinonesulphonate such as is referred to in the preceding note.

90. "*The Hydrolysis of Sulphonic Acids.*" By A. K. MILLER, Ph.D.

On page 93 of this year's *Berichte*, Kelbe states that the method of hydrolysis described by Professor Armstrong and the author (*Trans.*, 1884, 148), yields unsatisfactory results, especially when applied to the decomposition of bromotoluenesulphonic acid and similar compounds. He introduces a modification consisting in the employment of superheated steam, which, he maintains, so far improves the method that excellent results are

hydrocarbons. The author describes experiments on the recovery of orthobromotoluene from its sulphonic acid, the results of which show that Kelbe's modification is a complication rather than an improvement, the percentage yield of bromotoluene when steam at 100° was employed being equal to the percentage yield in the experiments described by Kelbe.

91. "*The Action of Bromine on Toluneparasulphonic Acid.*" By the same.

The bromotoluenesulphonic acid used in the experiments mentioned in the previous notice was prepared by heating an aqueous solution of potassium toluneparasulphonate with bromine. Potassium orthobromotoluneparasulphonate [$CH_3 : Br : SO_3K = 1 : 2 : 4$] was found to be the chief product, but besides this parabromotoluene and parabromobenzyl bromide were obtained, together with an oil which is thought to be orthoparadibromotoluene, and a solid substance melting at about 250°, the composition of which has not yet been determined.

DISCUSSION.

DR. PERKIN remarked that a method capable of yielding a pure bromo-derivative such as orthobromotoluene would be of value; he had recently prepared bromobenzene from aniline by Sandmeyer's process, and had found that it contained a sufficient amount of impurity to affect its physical properties.

Dr. ARMSTRONG said that the orthobromotoluene obtained by Dr. Miller had a constant boiling-point. He would recommend Dr. Perkin to prepare bromobenzene in the ordinary way, to sulphonate it and purify by means of one of the salts, and then recover it by hydrolysis.

92. "*Phosphorus Tetroxide.*" By T. E. THORPE, F.R.S., and A. E. TUTTON, Associate of the Normal School of Science, South Kensington.

The authors have examined the product formed by combustion of phosphorus in a limited supply of air, with especial reference to the statements of Reinitzer (*Ber.*, 1881, 14, 1884) that when dissolved in water, under certain conditions, it gives a solution of a light-yellow colour, and that after dialysis this liquid is found to contain a body of perfectly neutral reaction, and coagulates on being heated to 80° after addition of a few drops of mineral acid.

The authors, having repeated Reinitzer's experiments, are unable to confirm the existence of this so-called colloidal modification of phosphorous oxide. The yellow colour of the solution is due to the presence of the phosphorous suboxide of Le Verrier as an extremely finely divided powder, which can be removed from the liquid by repeated filtration. The colourless solution has a strong acid reaction, shows no turbidity on heating to 80°, and gives all the reactions of phosphorous acid.

When the mixed products of combustion of phosphorus are heated *in vacuo* to about 290—300°, phosphorus suboxide is formed, together with a sublimate of colourless, transparent, rhombic crystals.

These crystals sublime *in vacuo* at 180°, and are extremely deliquescent; they dissolve in water with formation of a solution of orthophosphoric and phosphorous acids, and on analysis give numbers agreeing with the formula P_2O_4. From the mode of action of water upon it, which is analogous to that of water upon N_2O_4, the authors are inclined to believe that this substance is the true tetroxide of phosphorus, and not the anhydride of the so-called phosphorosophosphoric acid, or hypophosphoric acid, discovered by Salzer.

93. "*Conversion of Ditolane-azotide into Diphenanthrylene-azotide.*" By FRANCIS R. JAPP, F.R.S., and COSMOS INNES BURTON, B.Sc.

In a previous communication on the ammonia-derivatives of benzoïn (*ante*), Japp and Wilson showed that the so-called "benzoïnimide" of Erdmann, to which this author assigned the formula $C_{14}H_{11}N$, had in reality

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94. "*A Chemica*
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Mr. WARINGTON
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further recollect that the sap of the green leaves has done far more work than the sap of the white leaves, its active constituents have indeed been consumed for the formation of tissue. The green leaves contain far more organic matter than the white; but this corresponds to only a small part of the work done. The green leaves have, in fact, furnished organic matter for the nourishment of the whole tree, and the organic substances transferred from the leaves to form woody tissue have doubtless been accompanied by the necessary sap-constituents. The sap of the green leaves is thus to a great extent exhausted sap. One constituent, however, preponderates in the green leaves, viz., lime. Salts of calcium occur largely as encrusting matter in old leaves; these salts have accumulated more in the green leaves, as a result of greater evaporation from the surface, and probably, from the removal of the carbon dioxide which held them in solution. In the white leaves there has been less evaporation, and a production instead of removal of carbon dioxide.

95. "*The Synthetical Formation of Closed Carbon-chains.* Part II. *Some Derivatives of Tetramethylene.*" By W. H. PERKIN, Jun., Ph. D.

In a previous paper (*Trans.*, 1885, 801) the author has shown that if the sodium compound of ethylic malonate be treated with ethylenebromide, ethylic trimethylenedicarboxylate (1, 1), $\begin{matrix}CH_2\\CH_2\end{matrix}\!\!>\!C(CO_2Et)_2$, is formed. The action of trimethylene bromide on ethylic sodiomalonate has now been studied, and the derivatives of tetramethylene thus obtained are described in the paper.

The first product of the reaction is ethylic tetramethylenedicarboxylate, $\begin{matrix}CH_2\cdot CH_2\\CH_2\cdot C(COGEt)_2\end{matrix}$, which is a colourless oil, boiling at 223°. On hydrolysis this salt is converted into tetramethylenedicarboxylic acid (1, 1) (m. p. 154—156°), which in its turn is easily converted on heating into tetramethylenecarboxylic acid, $C_4H_7\cdot COOH$ (b. p. 191°), and carbonic anhydride.

A second method of synthesising tetramethylene-derivatives is the following:—

The product of the action of one molecular proportion of ethylenebromide and two molecular proportions of ethylic malonate is ethylic butane-$\omega_2\omega_2$-tetracarboxylate, $(CO_2Et)_2CH\cdot CH_2\cdot CH_2\cdot CH(CO_2Et)_2$. When this salt is treated with sodium it forms a disodium-derivative, which by the action of bromine is easily converted into ethylic tetramethylenetetracarboxylate (1, 1, 2, 2), $\begin{matrix}CH_2\cdot C(COOEt)_2\\CH_2\cdot C(COOEt)_2\end{matrix}$.

Tetramethylenetetracarboxylic acid is a colourless crystalline mass, melting at 145—150°. On heating it is easily converted into tetramethylenedicarboxylic acid (1, 2) (m. p. 130°) and carbonic anhydride. The anhydride of this latter acid (m. p. 76—78°) is obtained by heating the acid to 300°.

Diacetyltetramethylenedicarboxylic acid,

$$\begin{matrix}CH_2\cdot CAc\cdot COOH\\CH_2\cdot CAc\cdot COOH\end{matrix}$$

is obtained in a similar way from the product of the action of one molecular proportion of ethylene bromide and two molecular proportions of ethylic acetoacetate. It is a colourless crystalline mass melting at 210°.

96. "*The Action of the Halogens on the Salts of Organic Bases.* Part II. *Tetramethylammonium Salts.*" By LEONARD DOBBIN, Ph.D., and ORME MASSON, M.A., D.Sc., Chemical Laboratory of the University of Edinburgh.

The actions of the halogens on the tetramethylammonium salts pretty closely resemble those on the trimethylsulphine salts described in a previous paper.

Of the addition products obtained from haloid tetramethylammonium salts, those which contain one atom of iodine are brightly coloured crystalline compounds of considerable stability. The crystals of the dibromiodide, Me_4NIBr_2, are orange, and those of the dichloriodide, Me_4NICl_2, are yellow. Both of these substances, like the corresponding trimethylsulphine-derivatives, take up ammonia gas, the dichloriodide doing so more readily than the bibromiodide.

A chlorobromiodide was not obtained by acting on tetramethylammonium bromide with iodine monochloride, but a dichloriodide was formed, the bromine being displaced by chlorine. In this respect the tetramethylammonium series differs from the trimethylsulphine series.

Those addition products which contain only bromine or chlorine, or both, are very unstable substances, and rapidly lose halogen in air, leaving haloid salts. Some of these were obtained in crystals but not in a pure state, being always mixed with some haloid salt.

An experiment in which tetrethylphosphonium iodide was acted on by bromine proved that the reaction took place in the case of the phosphorus bases also, a crystalline product being obtained.

97. "*Glycyphyllin, the Sweet Principle of Smilax glycyphylla.*" By EDWARD H. RENNIE, M.A. (Sydney), D.Sc. (London), Professor of Chemistry in the University of Adelaide, South Australia.

Smilax glycyphylla is a plant which grows in abundance on the shores of Port Jackson, and is common on the coasts of the northern parts of New South Wales and the southern parts of Queensland; the sweet principle extracted from its leaves has already been partially examined by Dr. Wright and the author (*Trans.*, 1881, 237). The author now corrects the formula previously given to $C_{21}H_{24}O_9$; glycyphyllin separates from aqueous ether with three, and from water with four and a half molecules of water of crystallisation. On hydrolysis, it yields *phloretin* and *isodulcite*:

$$C_{21}H_{24}O_9+2H_2O=C_{15}H_{14}O_5+C_6H_{14}O_6,$$

and is therefore closely allied to phlorizin, with which it is proposed to carefully compare it.

PHYSICAL SOCIETY.

November 13th, 1886.

Prof. BALFOUR STEWART, President, in the Chair.

IN opening the proceedings the PRESIDENT referred to the great loss which the Society had recently sustained by the death of Prof. Guthrie, F.R.S., the founder of the Society and his predecessor in the chair. In the capacity of Demonstrator Prof. Guthrie contributed materially to the success of the Society's meetings, and his decease is deeply regretted.

The PRESIDENT also announced that the Council were considering what steps should be taken to commemorate the late Dr. Guthrie, and that a circular expressing their views would be placed before the members in a few days.

The following papers were then read:—

On the Peculiar Sunrise Shadows of Adam's Peak in Ceylon. By the Hon. RALPH ABERCROMBY, F.R. Met. Soc.

The author prefaced his description by an extract from a paper on the same subject, by the Rev. R. Abbay, read before the Society May 27th, 1876, in which the explanation proposed is that the effects are caused by total internal reflection, as in ordinary mirage, the difference of air density being in this case due to the low temperature at high altitudes. The author pointed out that Mr. Abbay neglects the difference of density due to elevation, and that his own thermometric observations disprove conclusively any idea of mirage. The chief phenomena observed were, 1st, the appearance of a circular rainbow with spectral figures near the top of the shadow of the peak; and 2nd, a peculiar rising of the bow and shadow, which seem to stand up in front of the observers. Both

these effects are traced to the existence of mist clouds in the vicinity of the shadow. Two dark rays or brushes were seen to shoot outwards and upwards from the circumference of the bow, in directions nearly coinciding with the prolongations of the edges of the shadow, when seen projected on the lower mist clouds; but the author does not attempt to explain this phenomenon. On one occasion a second and outer bow was seen. The times during which the phenomena were visible were too short to permit sextant observations being taken, but the diameter of the inner bow was estimated at 8° or 12°. A totally distinct kind of shadow is sometimes seen from Adam's Peak just before and at the moment of sunrise, which seems to stand up against the distant sky. The author found, at Pike's Peak, Colorado, a similar effect, which is visible only at sunset.

Mr. G. GRIFFITHS remarked that he had often seen similar appearances to those described, in Switzerland.

In answer to questions by the President and Prof. S. P. Thompson, the author said the reason why the shadows were seen at Adam's Peak at sunrise and at Pike's Peak at sunset was that the configuration of the land on the west side of the former was similar to that on the east sides of the latter, both being low, whereas the opposite side were high, and therefore unsuitable for showing the phenomena. In all cases he believed the appearances due to the shadows being projected on clouds of suspended matter in the air at various altitudes. He had not noticed whether the colours were reversed in the second bow seen from Adam's Peak, but observed that this bow nearly, but not quite, touched the inner one.

"*Note on the Internal Capacity of Thermometers.*" By A. W. CLAYDEN, M.A., read by Prof. REINOLD, Secretary.

The author proposes to determine the volume v of the mercury by measuring the capacity c of a detached piece of the same tube of known length, and thence interring the volume of t degrees of the thermometer, the length of which is equal to the length of the tube taken. By assuming the value of α (the coefficient of apparent expansion of mercury in the particular kind of glass) to be known, the volume of the mercury in the thermometer can be calculated since $c = t\,\alpha\,v$.

Prof. RÜCKER remarked that there were often considerable differences in the sectional area of different parts of the same tube, and hence the method would probably not be very reliable.

On the motion of the PRESIDENT, a vote of condolence to Mrs. Guthrie on her sad bereavement was passed unanimously.

OBITUARY.

ROBERT ALEXANDER.

THE earthquake of August 31st, 1886, which spread consternation through so large a section of the United States, was especially disastrous in Charleston, S.C., in which city were many fatal casualties. Among the victims of this terrifying catastrophe was a young English chemist, Robert Alexander.

Mr. Alexander was born on the 18th day of March, 1863, at Tranmere, near Birkenhead, Cheshire. His father, William, and his mother, Margaret McLean Adam, were natives of Scotland, but removed to London about 1874, and young Alexander received his early education in the schools of the metropolis. While at school he developed a taste for chemistry, and while yet quite young made considerable progress in his favourite study.

After leaving school he was apprenticed to G. W. Wigner, F.I.C., F.C.S., the well-known analytical chemist. Here he became a skilled analyst, and soon obtained a position as Manager in the Fish Phosphate Works, on the Thames, some distance from London. He remained there about two years, but, desirous of seeking a larger sphere for his activity, he was induced to go to the United States, where his maternal uncle resides, and where he arrived in January, 1886. In the March succeeding he went to Charleston, S.C., the head-quarters of the fertiliser industry, and had only just taken hold of a sanitary system in that city when death came on the fatal night of August 31st. He was killed instantly in trying to escape to the street, being struck by falling bricks. His remains were interred in Magnolia Cemetery on September 1st. One who knew Mr. Alexander well says of him—"He had taken a wide survey of the domain of physical science; he was a careful, painstaking, and accomplished analyst, conscientious and thorough; while his beautiful simplicity and his noble Christian virtues not only endeared him to all who came in contact with him, but demanded that meed of recognition which such a character alone is worthy to receive."

NOTICES OF BOOKS.

Eighty-fourth Annual Report of the Chief Engineer of the Philadelphia Water Department for the Year 1885. Philadelphia: Dunlap and Clarke.

WERE we cynically disposed we might find in this Report no little scope for self-congratulation. Sanitary reform is difficult enough on this side of the Atlantic, and difficulties not a few are thrown in its way. But we have not yet heard of a municipality formally endeavouring to restrain one of its officials from lecturing on the perils of drinking polluted water. All persons who take an interest in the water supply of cities will find in this volume not a few most instructive facts.

We learn that certain large consumers of water, such as brewers, contrived to pay "about 50 per cent only of their actual dues to the City."

In another class of cases "certain persons having 'influence' of some sort seemed to have acquired a certain exemption from payment of water-rents altogether, and were shown to be delinquent for several years together."

Only about one-quarter of the dwellings in Philadelphia are closetted, though about one-half have baths. There are 7357 dwellings and 13,623 "half dwellings" not supplied with water at all.

The introduction of water-meters has effected a saving in the water consumption, which, in some instances, runs up to 70 per cent. Prior to the introduction of the meter "a pipe would be used to fill a tub, and the workman would throw the hose upon the floor and let the water run until he had again occasion to use it. In other cases a pipe in constant flow during the day would also be allowed to run after shutting down the mill. Leaking pipes were not repaired, nor were urinals and basins shut off." Such facts show that companies and municipalities would not necessarily be losers by adopting the meter instead of the inequitable system of payment by rateage.

It appears that 80 per cent of the Philadelphia water-supply is taken from the Fairmount Pool, which "is used in effect as a general cesspool for the riddance of the foulest and most deleterious waste matters, . . . the city itself permitting and participating in this violation of law and decency." Laws passed as far back as 1824, 1828, and 1832 did indeed forbid under appropriate penalties, the throwing or depositing in that part of the River Schuylkill which is between the dam at Fleet Rock and the dam at Fairmount "any carrion or carcass, any excrement or filth, any offal or noxious matter, or any matter or liquid from any dye-house or manufactory, calculated to render the water of the said river impure." These judicious laws remained dead letters, and when, in 1868, it was sought to revive them, the manufacturing interest

for the retention of the river as a sewer, and protested against an intercepting culvert. How little the citizens of Philadelphia are disposed to obey and support sanitary regulations, and with what impunity such laws can be set at defiance, appears from several cases which space does not permit us to quote.

From an order written by the Clerk to the Board of Health it appears that there are at least 50,000 cesspools (!) in the city, which, together with miles of leaking sewers and numerous graveyards, are constantly discharging foul matter into the bed of water underlying the city. Hence it appears that Philadelphia is, or at least was, still suffering from the nuisance of intramural interment. However, cremation is making good progress in the United States, so that we may hope this source of danger will soon be at an end.

Some experiments on the aëration of the water-supply of one district of the city are of profound interest. Comparative analysis showed a reduction of the free ammonia by 76 per cent, and of the albumenoid ammonia by 40 per cent, whilst the total solids are diminished and the nitrous acid eliminated altogether.

The reports of Profs. Mallet, Wormley, and Greene, and that of Dr. Leeds, clearly show the progressive pollution of the river, and point out the danger which will be incurred if once the bacillus of cholera is introduced into the water. These gentlemen, and indeed the Chief Engineer himself, show such a complete grasp of the subject, and expound the water question so clearly and fully, that the Philadelphians, if they still tolerate the use of polluted water, will be emphatically "sinning against better light and knowledge."

Report on the Chemical Examination of the Waters of the Public Wells of Albany, New York. By Willis G. Tucker, Ph.D. Albany: Burdick and Taylor.

The author, in the general description of the wells, prefixed to his analytical results comments very judiciously upon shallow wells in cities and populous districts as liable to sewage pollution. Even deep wells, he argues, in such localities can scarcely be preserved from animal contamination. In proof of the powerlessness of filtration to remove specific disease germs, he describes the decisive case which occurred at Lausen in 1872. But that typhoid fever and cholera "are seldom communicated in any other way" is scarcely a safe conclusion.

Dr. Tucker admits that a water, apparently chemically pure, may contain enough morbific matter to convey disease. For all this he holds that chemical analysis is of value in determining the sanitary rank of a water, since the more animal pollution can be traced the greater is the probability of morbific matter being sometimes introduced. He emphasizes the caution that the sensible properties of a water throw little light upon its real quality. It is satisfactory to learn that urban wells are being extensively closed in the United States. The analytical process employed is that of Wanklyn and Chapman. Of the thirty-six wells sampled he condemns fifteen as bad and thirteen as doubtful, while five are described as fair and three as good. The two former groups he recommends to be closed, whilst the two latter should be subjected to occasional re-examination.

CORRESPONDENCE.

RADICAL *v.* RADICLE.

To the Editor of the Chemical News.

Sir,—Mr. Madan's invitation, some months ago, to those chemists who refuse to replace the term *radical* by *radicle*, to defend their action, was accepted by me in your columns (Chemical News, liv., 71), and must be supposed to have placed before your readers all the grounds on which English chemists are being persuaded—I might say coerced—into making this replacement in their writings. An examination of Mr. Madan's letters seems to show that there is nothing at all to be said in defence of *radicle* against the objections I have raised to its use in place of *radical*; and that the only reasons for condemning the use of the latter term are that it is an erroneous Gallicism, and not a substantive but an adjective.

As to the argument for the rejection of *radical* on the score of its not being a substantive, that was met, in my first letter, by pointing out how many adjectives there are in *-al*, which are also used as substantives. I need, therefore, only address myself now to the task of upsetting the other argument, that *radical* must be rejected as being an erroneous Gallicism.

From a Ciceronian Latinist's point of view *radical* may, indeed, be fitly called a Gallicism, and *radicalis* be condemned when found in a Latin theme. But from the same point of view the French language itself, with all its perfections, may be described as being, for the most part, a *corrupted form of Latin!* and, indeed, is so described by grammarians, without thought of casting any slight upon it. Were Mr. Madan only to consider to what a pass English would be brought, were all the *corrupted form of Latin*, which, as French, has come into it since the Conquest, to be cast out, he would probably hesitate before condemning the use of such a long-established and serviceable word as *radical*, merely because it is a Gallicism. But he says, further, of it, that is an *erroneous* Gallicism. It is difficult to see in what consists this erroneousness. *Radicalis* is not found in a classical author, but it is just this fact which makes the use of *radical* a Gallicism. Linguistically, *radicalis* is an unimpeachable formation, and the actual Latin word *radicalis* pre-supposes it. It should be remembered that this word *radical*, treated with such contumely by Mr. Madan, is to be found in Provençal, and, for hundreds of years since to the present time, has been in use in French (and Italian) as a philosophical and scientific term, occurring in all departments of literary thought, and not as an adjective merely, but as a substantive. From French it has passed into German and English, and has become, perhaps, the commonest of philosophical terms in the literature of chemistry. Strange, since there was all along at hand the classical word *radicula* (L.), *radicule* (F.), *radicle* (E.), that this term should have been so long passed over in favour of *radical*, if it really has the needed signification, *radical*—the term adopted—being all the while but an erroneous Gallicism! *Radicle*, as I pointed out in my first letter, is certainly not capable of taking the place occupied so long by *radical*. Beyond a special technical use in botany, it has never crept into science till now in chemistry, never at all been used as an abstract term, but always with the force of a diminutive; whereas, be it rightly or wrongly formed, *radical* has ever been indisputably the adjective form of radix or root, with no sense of diminutiveness attached to it.

It is a gratification to me to see Mr. John Spiller so entirely with me in opinion (Chemical News, liv., 83); I was not aware till now, that he had so many years ago appeared in the Chemical News as an opponent to the substitution of *radicle* for *radical*. Concerning his reference to the paper in the *Journal of the Chemical Society* by Mr. Shimidzu and myself, upon *Mercury Sulphites*, it is as he supposes: the word *radicle* was not in our manuscript.

I would urge upon Mr. Spiller, and others agreeing with him and myself, to make a firm protest to the Publication Committee of the Chemical Society against their effort to enforce the use of *radicle* being longer continued, on the grounds that the recognition they are giving to this word is derogatory to the literary reputation of English chemists.

Mr. Spiller and those with him, as well as myself, in advising this course, could not be accused of presumption in making this protest, since they would only be deprecating the action of the Committee in repudiating, as unscholarly, the practice, not only of a past generation of English chemists and of many of the present time, but of the entire body of chemists, past and present, of France, Germany, and, indeed, all Europe.—I am, &c.,

EDWARD DIVERS.

The Imperial University of Japan,
October 1, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 18, November 2, 1886.

Atomic Weight of Gadolinium Oxide.—A. E. Nordenskiold.—(See p. 241).

Saturation of Selenious Acid by Bases and Acidimetric Determination of this Acid.—Ch. Blarez.—The reactions obtained with baryta water are distinct and precise, and may serve for the acidimetric determination of selenious acid. There is added to the acid liquid a drop of helianthine and a drop of phenolphthalein. The liquid becomes rose-coloured. When the baryta water has been added until half the molecule is saturated the liquid loses completely every trace of rose, and becomes yellow. The yellow remains until the molecule is entirely saturated, when it gives place to a new rose colouration.

Synthesis of Pentamethylene-diamine, Tetramethylene-diamine, Piperidine, and Pyrrolidine.—A. Ladenburg.—This paper does not admit of useful abstraction.

Two Novel Chloro-Derivatives of Methyl-benzoyl.—H. Gautier.—The compounds in question are trichloromethyl-benzoyl, and the corresponding bichloro-compound. The study of these two compounds shows how great is the stability of the chlorine which they contain in proximity to carbonyl, since, under the influence of the sparingly energetic reagents which easily attack the chlorine of the chloro-aromatic carbides contained in the chains, they are attacked only slowly. As for the more energetic reagents, their action bears upon the acetonic grouping, and we thus fall back upon a mono-substituted derivative simpler than benzol.

Novel Reaction of Aluminium Chloride; Syntheses in the Fatty Series.—Alph. Combes.—In studying the action of this reagent on a class of bodies containing oxygen and chlorine, the acid chlorides and the chlorinised aldehyds, the author has found a reaction which has enabled him to effect some syntheses. He has, in the first place, studied its action upon acetyl chloride, and has obtained a compound, $C_{12}H_{14}O_6Al_2Cl_8$. This compound is permanent in dry air, but it is at once decomposed by water.

Hæmatoscopy, a Novel Method for the Analysis of Blood, based upon the Use of the Spectroscope.—M. Hénocque.—This paper requires the three accompanying figures.

Bulletin de la Société Chimique de Paris.
Vol. xlvi., No. 4, August 20, 1886.

Transformation of Glucoses into Dextrines.—E. Grimaux and L. Lefèvre.—Already noticed.

Acidimetric Determination of Sulphurous Acid and of Sulphites.—Ch. Blarez.—The author refers to

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MISCELLANEOUS.

Treatment of Patent Affairs.—By Dr. G. Krause, of Cœthen.—We have of en observed that documents intended for the Patent Office, *e g.*, applica ions for patents, are not worked out with that care and knowledge which the importance of the subj ct unquestionably necessitates. Hence there arise for the inventor difficulties and expenditure which are not unimportant, and which might have been avoided if he had not rested in the belief that the documents drawn up by a professional expert must always bear the stamp of pract cal knowledge and conscientiousness. Above all things there is here delay in the course of the affair, and there is even the possibility of protecti n being refused in consequence of inaccurate or ambiguous specifications. Ap lications are sometimes made to us to know how such patent applications are to be re-cast, so that they may comply with the requirements of the Patent-Office. It will be manifest to any one who has been engaged in such affairs that such re-modellings are far more difficult and tedious than new commencements, and that in many cases the spec fication cannot be drawn up in the meaning of the original application. It is, therefore, absolutely necessary that the inventor should submit the documents, which are handed in to the Patent Office, in his name to a proper revision. In proof we will give a few examples with which we have recently come into contact. We were entrusted by an Austrian firm with a patent-application for Germany, and there was sent to us, by way of basis, the application which had been given in in Austria. This application, which referred to a new sizing for paper, was so superficial, and had been drawn up with so little knowledge of the matter, that it required a complete re-modelling in order to make the subject of the invention intelligible. Thus, ment on was made throughout of sulphates, instead of sulphites, though the former did not come into play at all. Instead of "dissolved sulphites" there was mention of "distu bed sulphites," "ab œtinic salt" instead of abiet nic salt, &c. In a word, the specification betrayed absolute ignorance of the very elements of chemistry. In another case a liquid was to enter a space and be converted into a vapour by collision with a solid surface, and was then, further, to undergo a chemical change by the introduction of a certain agent. The inventor, himself a chemist, had given a perfectly clear description of his process. But the expert had caused the liquid to enter the space as a vapour, and to undergo the subsequent transforma ion by contact with the solid surface. The final product was separated out as a "colourless powder." In spite of the false description the patent was granted, but it is substantially worthless, as it protects a process which the inventor does not use, whilst his real process is unprotected! Applications for patents are often fail, not merely of technical defects, but even of orthographical errors. The author finally cautions inventors to take the greatest care in the description of their processes, and to place them in the hands of trustworthy patent agents. (In England the patent agent consults with his client both on the preliminary and the final specification before filing, or, if this is not possib e on account of absence, a draft of the document is forwarded to the inventor for his approval. Still both technical errors and ambiguous language not unfrequently occur in specifications).

NOTES AND QUERIES.

*** **Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.**

Combustion Furnace.—Does any reader use the Glaser Combustion Furnace, and is it as satisfactory in working as Hoffman's?—ERLANA

MEETINGS FOR THE WEEK.

SATURDAY, 27th.—Physical, 3. "Note on a Method of Measuring the Coefficient of Mutual Induction of Two Coils," by Prof. G. Cary Foster, F.R.S. "On the Stability of Liquid Films," by Prof. A. W. Rücker, F.R.S.

TO MANUFACTURING CHEMISTS AND OTHERS.

THE METROPOLITAN BOARD OF WORKS will meet at the Office of the Board, Spring Gardens, S.W., on FRIDAY, the 3rd day of December, 1886, at Twelve o'clock at noon precisely, and will then be prepared to OPEN TENDERS by parties who may be willing to contract for the supply of 200 tons of Protosulphate of Iron (Commercial Green Vitriol) to the Main Drainage Pumping Station at Crossness, near Belvedere, Kent. Parties desirous to submit Tenders may obtain a copy of the Specification and Form of Tender, on application to the Chemist of the Board, at the Office, Spring Gardens, between the hours of Nine a.m. and Four p.m (or on Saturdays between the hours of Nine a.m. and Two p.m.), until Thursday the 2nd day of December, 1886). The Tenders, which must be on the form supplied from the Office, and addressed to the Clerk of the Board, are to be delivered at the Office before Four o'clock on the last-mentioned day, and no Tender will be received after that hour. The Parties tendering must be in attendance at the Board at Twelve o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected.

The Board do not bind themselves to accept the lowest or any Tender.

Spring Gardens, S.W., 18th November, 1886.

J. E. WAKEFIELD, Clerk of the Board.

The BADISCHE ANILIN und SODA FABRIK of STUTTGART and LUDWIGSHAFEN ON-RHINE *hereby give Notice* that Legal Proceedings will be taken against all Persons making, selling, or using any AURAMINE (patented March 26th, 1884, No. 5512) not manufactured by the Company or their Licensees, *The Society of Chemical Industry of Basle*.

All packages or tins of the Genuine bear the Patent Label and Trade Mark of the BADISCHE ANILIN UND SODA FABRIK, and of the SOCIETY OF CHEMICAL INDUSTRY OF BASLE.

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Mr. H. BECK, 12, Bush Lane, Cannon Street, London.
Messrs. JAMES STRANG and SON, 30, Gordon Street, Glasgow.

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" O. ISLER and Co., 1, Mosley Street, Manchester
" JAMES MOLLIN and SON, 4, Bentley Street, Bradford.
" ARTHUR and HINSHAW, 11, Bothwell Street, Glasgow.

J. HENRY JOHNSON,
47, Lincoln's Inn Fields, London, W.C.,
November 1, 1886. SOLICITOR FOR THE SAID COMPANY.

Silicates of Soda and Potash in the state of Soluble Glass, or in CONCENTRATED SOLUTION of fine quality, suited for the Manufacture of Soap and other purposes, supplied on best terms by W. GOSSAGE and Sons Soap Works, Widnes, Lancashire

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MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST.
SWANSEA.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.
FRANKLIN BARROW,
CLAYTON
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THE CHEMICAL NEWS.

VOL. LIV. No. 1409.

ON THE FADING OF WATER-COLOURS.*

By W. N. HARTLEY, F.R.S.,
Professor of Chemistry, Royal College of Science, Dublin.

UNDER the title "Light and Water-colours" an article has been published in the *Nineteenth Century* (page 849, No. 112, June, 1886), in which reference is made by the author, Mr. J. C. Robinson, to a correspondence conducted by various writers in the *Times* newspaper. This correspondence, which I have not had an opportunity of reading, appears to have consisted in no small measure of opinions and assertions incompatible with the observations of the author. It has been asserted by eminent authorities that water-colour drawings not only do not fade, but that they actually "deepen in tone" by age; but even those who assert that drawings do not fade, nevertheless admit that direct sunlight is detrimental in some way to water-colours.

Mr. Robinson maintains that water-colours are seriously injured by direct sunlight in a comparatively short time, and deteriorate by exposure to diffuse daylight to such an extent that he quotes the suggestion of Mr. Ruskin, made some years ago with reference to Turner's drawings, that they should be kept either in portfolios or—if framed and glazed—in cabinets from which light is excluded.

Considering the inestimable value of the works of Girtin, John Varley, De Wint, Copley Fielding, Turner, and David Cox, every lover of pictures will appreciate the importance of any definite information on the subject of the action of light on colours, inasmuch as it will afford a means of arriving at a decision on this question.

Works in water-colours are painted with pigments of two distinct kinds, namely:—

(1.) Mineral substances: for the most part these are—
Metallic oxides.
" sulphides.
" silicates.

(2.) Organic substances:—
Stable colouring-matters.
Unstable and changeable colours.

With the exception of ultramarine and colours containing lead or mercury, the bodies of the first class may generally be considered as unalterable; those of the second class may be considered as alterable *under certain conditions*.

It has been shown by the researches of Chastaing—"Etude sur la Part de la Lumière dans les Actions Chimiques" (*Annales de Chimie et Physique*, Series 5, vol. xi., p. 145)—that the chemical action of light upon mineral substances promotes oxidation by means of the red rays of the spectrum, the oxidising power, however, diminishes as the rays are more and more yellow in colour; the green rays are without action, and form a neutral region; but the blue rays reverse the action of the red, for they promote the reduction of compounds to the metallic state, and this reducing action increases in power as the rays of the spectrum decrease in wavelength, being at the maximum in the extreme violet region. With organic substances the chemical action of light is quite different; it promotes an oxidising action throughout, commencing in darkness; it continuously increases in power as the rays extend through the red and yellow into the violet end of the spectrum. There is, however, a modification in the green; the oxidising power then

* A Paper read before the British Association, Birmingham Meeting, Section B.

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carried on, is always acid, and the moisture of such air may be regarded as a mixture of very dilute sulphuric and sulphurous acid. The air of Manchester, for instance, in the centre of the town, may be perceived to be distinctly sulphurous in flavour, even in fine summer weather. This condition of the air is no doubt capable of causing serious injury to water-colour drawings. In a similar manner galleries which are lighted by gas, unless very efficiently ventilated so that the products of combustion are removed as fast as generated, are liable to receive upon their walls a deposit of dew which is acidified with sulphuric acid. This is well understood to be injurious in libraries. The sizing of paper may in time become acid if damp; the paper itself may be acid, for the fibre of which it is made is subjected to treatment with dilute acids, and the subsequent washing with pure water does not entirely remove the acid reaction from linen fibre. Many samples of the best drawing paper have recently been carefully tested, and the result has shown that it has always an acid reaction. This no doubt could in time act injuriously upon certain pigments, among which ultramarine may be particularly mentioned. This blue is very easily destroyed by the action of dilute acids. Size which has an acid reaction should never be used for drawing paper.

Having considered the acidity of the air and of the paper, it is necessary not to omit an examination of the colours. To the credit of the colour-makers be it said, that of sixteen tints commonly used in out-of-door sketching, only one, bistre, had a slightly acid reaction: the neutral character of the other preparations is decidedly in favour of their stability; furthermore, they are not likely to react on each other. Certain lakes which were known to the ancients, such as those prepared from the madder, are of remarkable stability, and so likewise in a greater degree are various preparations of indigo. It may be remarked that a particular blue colour found in the wall paintings decorating the baths of Titus was of organic origin, since Sir Humphry Davy proved it to be combustible. The only blue colour of an organic nature known to the ancients was indigo (*indicum purpurissimum*): there can be little doubt that this blue was indigo, and that it had withstood the action of air and sunlight for ages. In fact, neutral or alkaline indigo is a remarkably permanent pigment.

Chemists are familiar with the fact that *solutions* of *indigo* made with acids are converted, under the action of air and sunlight, into a brown substance. Hence it is obvious that acid preparations of indigo may undergo a similar change if washed over paper.

Gamboge in time is bleached by exposure to air and sunlight; this fact may be observed in many drawings which have been hung for the last fifty years.

In order to satisfy myself as to the alterability of colours I have made delicate washes of pigments on drawing paper of the first quality. The sheets of tinted paper were cut into two or three pieces; one was kept in the dark, one was exposed to the light, and a third was treated with hydrogen peroxide, and in some cases with a solution of sulphurous acid. It was considered as most probable that, in cases where the effect of sunlight is to promote the action of the oxygen of the air upon the organic colours, the result obtainable by air after a long exposure might be secured by the action of hydrogen peroxide with but little aid from the sun. The use of sulphurous acid was of course intended to show the probable effect of an atmosphere polluted by the combustion of much sulphurous coal or coal-gas. The colours tested were—

Blues.—Indigo, cobalt, ultramarine.

Yellows.—Gamboge, Indian yellow, cadmium orange, cadmium yellow, yellow ochre.

Reds.—Light red, Indian red, vermilion, crimson-lake.

Greens.—Viridian, olive-green, brown-pink, emerald-green.

Browns.—Brown madder, bistre, sepia.

Of these the following were affected by hydrogen peroxide—olive-green is rendered slightly bluish in tint.

The following were affected by sulphurous acid:—Ultramarine, cadmium yellow, and Indian yellow. The first is bleached; the second nearly bleached, being converted into a very pale muddy yellow, and the same may be said of the third.

Vermilion has its brilliancy destroyed; it is rendered muddy and heavy-looking by sulphurous acid.

The other pigments were unaffected.

Considering now the action of sunlight, the blues were quite unchanged by exposure to air and sunlight for six hours a day for fourteen days.

Yellows.—Light washes of gamboge are completely bleached by exposure to pure air and intermittent sunshine for only three days, or in all eighteen hours; in a week's time even strong washes are much lightened in colour, and rendered dull if not bleached, while even three hours produce a very visible effect.

Reds.—Crimson-lake was the only one affected. Six hours' exposure to sunlight and air almost bleaches light washes, while three days, or eighteen to twenty-four hours with intermitent sunshine, cause even dark crimson to become very much lighter, and the purity of the colour is destroyed.

Greens.—Olive-green and brown-pink are rendered lighter in colour by six hours' exposure to sunlight and air. The olive-green becomes bluish and the brown-pink becomes brownish in hue and much lighter.

Browns.—Brown madder is slightly lighter after eight days, or forty-eight hours' exposure. Bistre fades with great rapidity; a light wash appeared much lighter after six hours. Sepia undergoes a change in colour which can scarcely be described as a tendency to bleaching; the tint becomes colder, but not very perceptibly lighter.

The action of sunlight, it will be noticed, differs from that of peroxide of hydrogen, and it may be regarded as probably not an oxidising action. To put this matter to the test and to ascertain whether a more permanent character might not be conferred on these unstable colours by protecting them from the action of air, the following tints were put upon paper in circular washes:—Crimson lake, gamboge, bistre, and olive green. Each disc was cut into three slips; one was kept in the dark, the second was exposed to light and air, and the third was enclosed between two plates of glass, the edges of which were kept together by gummed paper, which was made to enclose them completely and prevent the passage of air between the plates. The coloured discs were four inches in diameter. In the course of five hours it was found that the slips tinted with crimson lake and bistre and kept under glass were considerably altered, somewhat more so, it even appeared, than those which had been exposed to air; this was caused, however, by the very slight tint of the plate glass. It cannot be supposed that the air was absolutely excluded in this experiment, neither must the fact be overlooked that possibly there was sufficient air between the plates of glass to cause the colours to change; hence it is desirable that this experiment should be tried in modified form. The change in the colours was, however, progressive for several days, and hence it is extremely improbable that the colours were being oxidised. It is a proof, however, if proof be deemed necessary, that framed water-colours should, under no circumstances, be subjected to direct sunlight. Judging of the course of the chemical change, as observed to take place in lake and gamboge, it certainly appears as if the effect of sunlight on these colours was not one which induced oxidation, but rather a shaking asunder of the molecules into two or more colourless bodies.

It may be remarked that an impure atmosphere affects all preparations of lead; no preparation of this metal should be sold as a pigment, either for oil or water-colour painting. Some years ago Chinese white was made of white-lead, and in course of time it became brown; some shades of vermilion appear to be mixed with red-lead, and they

ides, and is apt to become dirty in appearance subsequently. In short, the only preparation of either of the metals lead or mercury which should be used is pure cinnabar or vermilion, the sulphide of mercury. It is now obvious that mineral and organic colours, when used in combination, may be altered in this respect, that the mineral colours remain after those of an organic nature have been destroyed; or the more easily destructible of the organic colours may be destroyed, such as gamboge and crimson lake, and those of a more stable character, such as indigo, remain. With regard to the statement that water-colours do not fade there is this much truth, that many works of art, by ordinary exposure to diffused daylight in rooms and picture galleries, do not appreciably alter. It is also correct, according to my own observations, that some works, painted with colours which have been known to alter in certain cases, have been preserved, even though exposed to daylight for such a time as would lead to the expectation of seeing them changed.

There is little doubt that the surrounding conditions have made the difference. All the examples of the work of Girtin and John Varley which I have seen, and even some of the earlier pictures of De Wint and Copley Fielding, have suffered by some of the colours having faded. The trees have a sombre and unnatural blue tint, with here and there indications of brown, and the tone of colour is cold. The cause of this is doubtless due to the blue and the brown tints having remained, while the yellow has faded. It is probable that crimson lake has gone out of the foliage shadows. This change is, no doubt, one which may be described by saying that the work has "deepened in tone" by age, but the reason is that *the light of the picture has faded out of it.* The tints, therefore, are relatively darker, but not absolutely so. In some cases the blues may have suffered, but there is no appearance of this in any work that I can call to mind, with the exception of an alteration in the colour of clouds, which will be dealt with presently. There is one other cause for the "deepening of tone" in a water-colour drawing which must have been seen by everyone who has carefully examined a number of old drawings. The picture being on a white ground, the paper by age has become brown, as all paper does; the effect of this is of course a deepening of tone, in fact the effect is much the same as if the original were viewed through a glass tinted pale brown. One of the most valuable of pigments for clouds, distances, and shadows is ultramarine; with Indian red and light red it produces beautiful rich purple tones and cool greys, which exactly correspond with tints in the atmosphere. The value of these tints lies in the fact that they represent atmospheric effects seen when viewing distant mountains, the shadows of clouds, and other luminous shadows, and the reason is that the colour of the clear atmosphere is blue, and this is the medium through which other colours are seen. Whenever these tints have been mixed with ultramarine, as the blue pigment, the pictures are of a nature liable to suffer from the action of acids, and the atmosphere of a smoky town I should consider likely to be in the highest degree injurious to such works. The instance of dark purple or rich grey clouds becoming red, by the destruction of the blue pigment and the survival of the red with which it was mixed, is one which I have observed, and I am thus in agreement, so far, with Mr. J. C. Robinson's statement on the subject. He refers to the blue as being indigo, whereas that which was originally used in the works which have come under my observation was ultramarine, and my view is that it was destroyed by an acid and not by oxidation, or any such action induced by sunlight. If there are any well authenticated cases of indigo being destroyed when mixed with mineral reds there are also other instances of such a mixture being unaffected. Under these circumstances it would be well to consider the possibility of red pigments reacting on indigo. The fact has already been mentioned that

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for four hundred years, and probably for eight or twelve hundred years, if the yellow rays alone were used, or if the violet and the blue rays were diminished in quantity by the passage of light through blinds of unbleached linen (brown holland). It will be necessary to make exact experiments to dispose of all doubt concerning this point.

As far as lighting by electricity is likely to affect pictures the difference in intensity of action between the yellow and the violet, and those rays which lie beyond the violet, is a reason for a decided preference for incandescence lamps; the rays of the arc light are not only much more intense throughout the spectrum, but exceedingly rich in the violet and ultra-violet region, and therefore capable of very intense chemical action. The use of arc lights in a gallery of water-colour drawings must be considered as an unsafe mode of illumination, the adoption of which cannot be recommended.

In conclusion, it is obvious that those who desire to preserve valuable water-colour drawings should see that they are kept in a dry, pure atmosphere, and away from the influence of direct sunlight. Diffused daylight, when the drawings are not being exhibited, should be reduced by blinds of unbleached linen, which transmits a yellow or brownish light.

It is better in every case that water-colour drawings of importance, if possible, be executed on paper stretched on a drawing board in the usual manner, by applying gum at the edges only, and, instead of being removed and transferred to cardboard mounts, it would be safer for them to remain on the board and so be framed. In this way no adhesive preparation would be put at the back of the picture. For the same reason sunk cardboard mounts are advantageous, for it is necessary then to moisten only the edges of the picture with adhesive material.

ON THE METHOD OF CONDENSATION IN CALORIMETRY.*

By J. JOLY, B.E.,
Assistant to the Professor of Civil Engineering, Trinity College, Dublin.

A SUBSTANCE at the initial temperature $t_1°$ of the atmosphere, suddenly immersed in a saturated vapour at the higher temperature $t_2°$, abstracts from it a quantity of heat equal to $WC(t_2° - t_1°)$, where C is the thermal capacity of the substance between the limits $t_1°$ and $t_2°$, and W its weight. There is then a weight w of the vapour precipitated, so that—

$$WC(t_2° - t_1°) = w\lambda,$$

λ being the latent heat of the vapour.

By the observation of the weights and the temperatures, either c or λ may be the unknowns sought from the equation. The method is, in short, applicable to the determination of the specific heat of a substance or the latent heat of a vapour.

The paper contains an account of experiments illustrating the application of this method of condensation to the determination of the specific heats of substances. The condensation of steam is employed, its latent heat being accurately known, and its use affording a considerable range of temperature. Two forms of the apparatus employed are described. The calorimeter consists essentially of a vessel of thin metal in which the substance is suspended by a fine wire, the wire issuing through an aperture in the top of the vessel and reaching up to one arm of a balance. The vessel is so constructed that steam can be passed through it from a small boiler, displacing the air around the substance. The substance rests on a water beneath to receive the drops of condensed water.

The manipulation involved is very simple. The substance, being placed on the carrier which depends from the balance, is counterpoised. The calorimeter is then closed around it, the suspending wire passing freely through the aperture provided. This aperture is formed in an absorptive material (plaster-of-paris), which ensures that it remains free of precipitated water. A thermometer reading to 1-10th degree C. is inserted in the calorimeter, and allowed to remain with the substance for an interval sufficient to secure close equilibrium of temperature. The thermometer being read is removed, and the calorimeter suddenly placed in connexion with the boiler, which supplies a brisk current of steam and fills it immediately. It then remains to note the increment of weight when the substance has finally attained the temperature of the vapour. This stage is revealed in the persistent equilibrium of the balance: $t_2°$ is observed directly by a thermometer inserted in the boiler, or deduced by noting the height of the barometer and seeking the corresponding temperature of saturated steam from Regnault's tables. A correction is applied to the weight observed in experiment, necessitated by the difference of the weights of the displacement of the substance in air and in steam. In accurate experiments the value of λ is corrected according to Regnault's formula for its true value at $t_2°$.

The method is convenient for the reasons that it involves no preparations as in Bunsen's change of state method, no delicate thermometry, and the calorimeter being roomy permits of bodies of various shapes and bulks being dealt with. The apparatus, too, is of a simple and durable nature.

The experiments quoted in support of the method are (1) on the metallic elements, zinc, silver, lead, platinum, and aluminium. The results are in accord with those of Regnault, Bède, Mallet, &c. The degree of consistency between the experiments is greater than that attained in Regnault's researches. (2) On pure water sealed in thin glass bulbs. The results agree closely with the values deduced from Regnault's formula. (3) On mineral substances in various states of aggregation. It appears from these that the result is but little influenced by the extent of surface exposed to the steam.

The accuracy displayed by the method is explained on the probable supposition that the substance is throughout the period of heating coated with a film of water adiathermanous and the external surface of which may be considered as appreciably that of the steam. The danger then of radiation error, that is, of steam condensing elsewhere than at the surface of the substance, is small. Condensation, in short, may be considered as taking place by abstraction of the energy of the molecule on impact with the water film.

* Abstract of a Paper read before the Royal Society, November 18th, 1886.

ON THE MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 254.)

8. *Test for Potassium.*

WHEN testing for potassium we add a little perchloride of platinum to the drop which we have examined for crystals of gypsum. To effect this we make use of a little hook of platinum wire the end of which is sealed into a glass tube (loops are not so good as hooks for this purpose, because of the difficulty in cleaning them properly); we get a drop of the reagent on the end of the wire and then let it run into the middle of the drop under examination. The crystals of potassic chloroplatinate form in the course of a few minutes, generally along the edge of the drop; we can employ the time, while waiting, by pre-

paring for the sodium and aluminium tests. When the crystals do not form quickly we can have recourse to alcohol, as has been already described.

The potassic chloroplatinate forms pale yellow octahedrons, very well formed, and having considerable refracting power. Their size varies from 10 to 30 microns. Concentrated solutions generally give a mass of small crystals, which often join together, forming twins or resembling the ace of clubs.

In solutions of chlorides the crystals form more easily, and are of smaller dimensions than in solutions of sulphates. A large excess of sulphuric acid interferes considerably with their formation.

Perchloride of platinum furnishes us with a microchemical reagent for detecting potassium, which leaves nothing to be desired. The reaction is certain, easy to observe, and as the presence of cæsium and rubidium is very rare it is very characteristic and sensitive. It enables us to detect 0·0006 m.grm. of oxide of potassium. Hydrofluosilicic acid acts less rapidly, and the fluosilicate of potassium is much more difficult to recognise than the chloroplatinate.

The action of phosphomolybdic acid and phosphomolybdate of sodium is still slower than that of hydrofluosilicic acid; the separation of the potassic salt from a solution containing 2 per cent of potassic sulphate does not commence until the margin of the drop commences to get dry. But the crystals resemble those of potassic chloroplatinate, both as regards size and colour; the octahedric crystals of the two compounds are so much alike as to be taken one for the other. We find the same trefoil crystals in both kinds; however, the ordinary form of phosphomolybdate of potassium is the rhomboidal dodecahedron. Ceric sulphate added to solutions of potassic sulphate forms a double salt as quickly as perchloride of platinum, but not so well characterised either by form or colour. I shall refer to this double salt again in the following paragraph.

9. *Test for Sodium.*

The test for sodium, above all, presents great difficulties. I have long been hunting for a reagent which would indicate the presence of this metal; and at last my choice has fallen on cerous sulphate. This salt indicates, as does also hydrofluosilicic acid, the presence of potash as well as of soda. But whilst M. Boricky's reagent is more adapted to showing the presence of potassium rather than sodium, cerous sulphate acts in exactly the opposite manner. In fact, the double sodic salt appears long before the potassic compound. The double salts of ammonium and lithium are much more soluble; this property is possessed, but in a much higher degree, by the double calcic and magnesic salts, which furthermore form crystals of a totally different character. The yellow ceric sulphate gave no satisfactory results. We use the cerous sulphate in a concentrated solution, and place a drop of it at about 5 m.m. from the drop to be tested. We mix the two liquids by means of a fine glass rod; gradually we see forming in the cerous sulphate solution small facets of crystals, resembling desmine, which are nothing else but cerous sulphate, but at the edge, on the contrary, and especially if the quantity of sodic salt present is at all considerable, a zone thick and cloudy, coloured brown, and formed of the double sodic salt. In case potassium is present, we see appear in the middle of the zone just described another one coloured grey and granular in appearance, formed of the double potassic salt.

We can easily convince ourselves, by increasing the magnifying power to about 600 times or more, that these cloudy parts consist of little transparent grains, of hardly 2 microns in diameter (the sodic salt), and of spheroids a little larger, of about 5 to 8 microns in diameter (the potassic salt). These last have a slight resemblance to the starch granules of potatoes.

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ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 248.)

As further illustrating the differences in the results, the following table is presented :—

	Percentage of results differing from mean not more than—						
	0·3 p.c.	0·5 p.c.	0·7 p.c.	1·0 p.c.	1·5 p.c.	1·3 p.c.	1·7 p.c.
Sample A.							
Moisture	81	81	81	92	92	100	—
Soluble	80	100	—	—	—	—	—
Insoluble	40	54	74	80	100	—	—
Total	87	100	—	—	—	—	—
Sample B.							
Moisture	73	73	82	92	92	92	100
Soluble	34	66	87	100	—	—	—
Insoluble	72	93	100	—	—	—	—
Total	87	87	100	—	—	—	—
Sample C.							
Moisture	73	82	82	92	92	92	100
Soluble	94	100	—	—	—	—	—
Insoluble	40	60	66	74	94	100	—
Total	80	94	100	—	—	—	—
All determinations (not including moisture) taken together	68	84	92	95	99	100	—
P_2O_5 determinations excluding insoluble	77	91	98	100	—	—	—

In connection with these results the following points may be noticed :—

1. The determinations of moisture, while somewhat better than those reported last year, are not as uniform, by any means, as could be desired.

2. The determinations of total P_2O_5 on the whole are satisfactory. The extreme variations between the highest and lowest results are for A, 0·83 per cent; for B, 0·83 per cent; for C, 0·82 per cent. Of the results upon A, 0·87 per cent differed from the average not more than 0·3 per cent; of B, 0·87 per cent, and of C, 0·80 per cent.

In order to determine as accurately as possible the content of total P_2O_5 in the samples, numerous special determinations were made by the Chairman of the Committee. Reagents and manipulation were proved satisfactory by determinations made upon solutions of C. P. hydro-disodic phosphate and of microcosmic salt, recrystallised, the strengths of which were proven by evaporation and ignition, and by precipitation with magnesia mixture. A series of molybdate determinations gave a mean error of less than 0·15 per cent.

(1) 0·5 grm. of sample was digested with 20 c.c. concentrated HCl, diluted and filtered.

(2) 0·5 grm. was covered with 5 c.c. saturated solution of $Mg(NO_3)_2$, evaporated, ignited, and dissolved as above.

The following results were obtained :—

	A.	B.	C.
1	19·00	18·48	17·71
	18·94	18·60	17·80
	18·96	18·54	17·76
2	18·89	18·50	17·70
	18·97	18·61	17·81
	18·92	18·49	17·72
Average	18·94	18·53	17·75
Average from Association chemists	18·95	18·55	17·80

3. The determinations of soluble P_2O_5 are fairly satisfactory. The greatest extreme variation is 1·55 per cent in the case of sample B, and results upon this sample (which contains the largest percentage of soluble) are much more discordant than for the others. Certain experiments were, therefore, made upon this sample.

1. 2 grms. were placed upon a dry filter and water added slowly and in small quantities until the filtrate measured 200 c.c.; 2. 2 grms. treated as above until the filtrate measured 250 c.c.; 3. 2 grms. treated as above until the filtrate measured 300 c.c.; 4. 2 grms. treated as above until the filtrate measured 500 c.c.; 5. 2 grms. were placed in a beaker, about 150 c.c. of water added, stirred and rubbed with a stirring rod, filtered and washed until filtrate measured 300 c.c.

An aliquot was taken for determination in each case, after thorough shaking of the fluid and a small quantity of HCl added to clear up any possible cloudiness.

The results were as follows :—

	1.	2.	3.	4.	5.
Sample B, soluble P_2O_5	10·52	11·35	11·56	11·55	10·21
	10·53	11·27	11·44	11·51	10·16
Mean	10·58	11·31	11·50	11·53	10·18

These results indicate the necessity for slow washing with small quantities of water and for continuing the washing to the proper point. Acid reaction in the last drop of the filtrate was barely discernible in 2, after 250 c.c. of water had been used, and yet 50 c.c. more extracted nearly 0·20 per cent soluble P_2O_5.

4. The "insoluble" determinations are extremely unsatisfactory. The extreme variations are, for A, 1·64 per cent; for B, 0·91 per cent; and for C, 2·39 per cent. As upon this determination depends the estimation of the "available" P_2O_5, its importance is obvious. These discrepancies cannot be due to differences in the samples.

The close agreement in total P_2O_5 evidences strong probability that the samples were uniform. The same fact indicates that there is no fault in the method used for determining the P_2O_5 (molybdate and magnesia mixture). The difficulty is evidently in the character and manipulation of the citrate solution.

The committee is at a loss to know what to suggest in this connection, except it be to reiterate the cautions hitherto urged as to the strict neutrality and specific gravity of the citrate solution and careful attention to the specified temperature.

III. The committee recommends the continuance of the present general method for the determination of the

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

phosphoric acid, subject to such modifications in minor details as the Association may determine.

Respectfully submitted.

H. C. WHITE, Chairman.
E. H. JENKINS.
W. C. STUBBS.

(To be continued).

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, November 5th, 1886.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 182 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

The general character of the water supply of the month continued to be excellent. Nothwithstanding the alteration in character of the season, the mean proportion of organic carbon in the Thames-derived supply, as compared with that of the previous month, had increased only from 0·132 part to 0·140 part in 100,000 parts of the water; while the maximum proportion in any one sample fell short even of the maximum of the previous month.

The series of bacteriological experiments, of which the particulars are given below, differ from those recorded in our previous monthly reports in the circumstance that the water subjected to infection had not been previously sterilised, but was infected at once as drawn from the service-pipe. Before commencing this series of experiments, we had to satisfy ourselves that the growths set up in the testing culture-fluid by the innocuous and presumably beneficent forms of microbe life naturally present in the water could be clearly distinguished from the growths set up by the purposely introduced morbific microbes, by the greater length of time needed for incubation, by the naked eye appearance of the growth when formed, and more particularly by its microscopic examination. Seventeen duplicate experiments were made, corresponding, of course, to thirty-four infections, mostly on different days from April 13th to April 29th, inclusive. In each infection a quantity of peptone-fluid, loaded with an active sporeless growth of *Bacillus anthracis*, was added to the freshly-drawn water, in the proportion, as nearly as might be, of 1-500th, or from the 1-400th to the 1-600th of its bulk. To contaminate to the same extent a single day's supply of the Thames water alone actually furnished to London would r
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98. "*Research Structure of Ca Spectra.* Part- *and Dyes.*" By of Science, Du

The author refers to a paper by Dr. Otto N. Witt, published in 1876, in which it is stated that the tinctorial characters of benzenoid compounds is conditional upon the simultaneous presence in the molecule of a colour-producing group and a salt-forming group of atoms; a group of atoms of the former kind being designated a *chromogen*, and of the latter a *chromophor*. He has studied the relation of the hydrocarbons to the more complex compounds which are colouring matters derived therefrom. It is shown that benzene and the derived hydrocarbons have the property of selecting and absorbing certain rays of the spectrum, and may thus be regarded as coloured bodies, the colours of which are too subtle for the eye to perceive them. By certain reactions, two or more benzenes may be linked in such a way that the rate of vibration of the new molecule is reduced so that it absorbs rays within the region of visibility. That which has been called a chromogen is an invisibly coloured substance, and that which is termed a chromophor is an atom or group of atoms capable of so reacting as to reduce the rate of vibration of the molecule, with the result that it absorbs rays of no higher refrangibility than the violet. Under certain conditions oxygen and nitrogen are chromophors, hence also hydroxyl and nitroxyl.

The spectrum measurements of a number of nearly related dyes and colouring matters are given, together with diagrams indicating their molecular vibrations.

The modification seen in the curve of benzene when an alkyl radicle displaces hydrogen consists in three out of the four absorption-bands being merged in one, and the rate of vibration of the absorbed rays is less.

When a body like triphenylmethane is examined, the absorption curve has much of the general character of that of benzene, but the modifications which it has undergone are much like what one might expect from its constitution. First, there is one broad band of absorption, with just an indication of a second being merged in this. Secondly, a great increase in the amplitude of the vibrations. Thirdly, the rate of vibration of the absorbed rays is greatly reduced.

When magenta, Hofmann's violet, and iodine-green are examined, it is seen that the curves are modifications of that of triphenylmethane; they follow each other closely, but the molecule of greatest mass transmits least light, and the light is composed of rays vibrating with least rapidity, thus indicating a greater amplitude and less rapidity of vibration of the molecule.

Azobenzene and a number of its derivatives of very varied constitution exhibit curves remarkably similar.

It is remarked that when absorption takes place in the visible region the ultra-violet rays are generally completely absorbed.

99. *Spectroscopic Notes on the Carbohydrates and Albumenoids from Grain.*" By W. N. Hartley, F.R.S., Royal College of Science, Dublin.

According to C. v. Naegeli ("Theorie der Gährung") fermentation is a process which may be described as the transference to fermentable matter of the molecular, or rather intra-molecular, vibrations of the different constituent substances entering into the composition of living protoplasm (which remains itself unchanged in composition), and hence the equilibrium of the molecules of the fermentable matter becomes so disturbed as to cause their resolution into simpler molecules. The author has had recourse to spectrum observations, in order to obtain, if possible, some information as to the mode and rate of vibration of the molecules of the bodies which initiate and participate in fermentative changes.

It is pointed out that animal albumens of various kinds examined by M. L. Soret are distinguished by absorption-bands produced by small thicknesses of dilute solutions, while the albumenoids invertase and diastase, and the water in which yeast has been washed, afford solutions which are very diactinic, and as far as could be ascertained do not exhibit absorption-bands. Moreover, gelatin is very diactinic when quite pure, and so also are the carbohydrates starch, cane-sugar, and glucose. It does not therefore appear that there is anything in the mode and rate of vibrations of invertase which is incompatible with a transference of its vibrations to glucose, nor of the vibrations of diastase to starch; hence it is possible that some material within the yeast cell may communicate its motion to the sugar outside of it, and so resolve the complex molecule into simpler molecules. Putting the theory of fermentation on one side, it is of interest to know that the facility with which the ultra-violet rays traverse solutions of the carbohydrates is quite in accord with what we know of their constitution, notwithstanding the complexity of their molecules. It is, further, no less interesting to know that the albumenoids associated with the carbohydrates are evidently of very different constitution from those found in the animal organism. It is pointed out that gelatin dry plates very rarely receive impressions of rays of higher refrangibility than 2146, and this is due to some slight impurity in the gelatin, since some specimens of gelatin transmit the line of zinc 2024.

Discussion.

Mr. Spiller, referring to the differences in sensibility of gelatin plates to the most refrangible rays commented on by Prof. Hartley, said that, owing to the difficulty experienced in getting silver bromide emulsion to set and dry sufficiently rapidly in summer time, it had sometimes been the practice of makers to add a minute proportion of chrome-alum: this might account for some of the differences observed.

Prof. Hartley said that he had long thought that the soluble bromides had not been completely washed out; but as plates prepared with special care for him by Messrs. Mawson and Swan had also manifested the differences described, he now thought that they were probably due to actual differences—some minute impurity—in the gelatin used at different times in preparing the plates.

100. "*Preliminary Note on the Electrolysis of Ammonic Sulphate.*" By Herbert McLeod, F.R.S.

When a neutral solution of ammonic sulphate is electrolysed in a U-tube provided with platinum plates as electrodes, nearly pure oxygen is evolved at the positive pole and hydrogen at the negative. For 1 volume of gas from the positive pole, a quantity varying between 4·7 and 5·4 volumes is evolved from the negative pole. A small amount of ozone is produced. On mixing together the electrolysed liquid at the poles a strongly alkaline liquid is obtained, containing a considerable quantity of "active" oxygen. When the liquid is first neutralised with sulphuric acid, then treated with excess of baric chloride, and the baric sulphate filtered off, the liquid deposits baric sulphate on boiling,—an indication of the presence of persulphuric acid in the solution.

When sulphuric acid that has been electrolysed is exactly neutralised with baric hydrate, the precipitate filtered off, and the liquid boiled, baric sulphate is precipitated; at the same time the liquid becomes acid, and a further quantity of baric sulphate is thrown down on the addition of baric chloride.

Discussion.

In reply to a question from the President, Professor McLeod said that Faraday, in the experiments which gave results differing from those now described, had used an alkaline solution of ammonium sulphate in ammonia.

Dr. Messel asked if the deficiency in oxygen might not be due to the formation of hydrogen peroxide. In experiments on the electrolysis of sulphuric acid solution (with a current of 60 ampères), he had at all events observed the characteristic colour on application of the chromic acid and ether test.

Prof. McLeod said that he had always failed to detect hydrogen peroxide.

101. "*The Preparation and Hydrolysis of Hydrocyanides of the Diketones.*" By Francis R. Japp, F.R.S., and N. H. J. Miller, Ph.D.

dihydrocyanide, $C_{14}H_{10}(OH)_2(CN)_2$, by means of concentrated chlorhydric acid, but without success. However, by dissolving benzil in alcohol, adding an excess of hydrogen cyanide, saturating the liquid with hydrogen chloride, and allowing the whole to stand for some weeks, a compound of the formula $C_{16}H_{12}N_2O$ was obtained, a reducing action having taken place. The compound crystallises from benzene in lustrous yellow flat needles or laminæ, melting at 196—197°. It is feebly basic, yielding a colourless hydrochloride which is decomposed by water. At the same time an acid of the formula $C_{16}H_{13}NO_4$ was obtained.

By the action of a strong aqueous solution of hydrogen cyanide upon phenanthraquinone, a dihydrocyanide, $C_{14}H_8(OH)_2(CN)_2$, corresponding with the benzil-derivative prepared by Zinin, was obtained. It crystallised in tufts of very slender needles, which when heated decomposed with evolution of hydrogen cyanide. Treated with fuming chlorhydric acid in the cold, this compound slowly evolves carbonic anhydride, and yields a mixture of two compounds, $C_{15}H_9NO$ (needles melting at 241°) and $C_{15}H_{11}NO_2$ (needles melting at 183°).

The compound $C_{15}H_9NO$ appears to be a lactam or lactim. It unites directly with metallic hydroxides to form salts, without elimination of water, and from the solutions of these salts mineral acids precipitate the original substance. It decomposes carbonates. The compound $C_{15}H_{11}NO_2$ is an acid; its salts appear to be isomeric with those of the compound $C_{15}H_9NO$, but are so unstable that satisfactory analytical figures could not be obtained.

In a preliminary note on the above subject (*Ber.* 16, 2418) the authors erroneously ascribed the formulæ $C_{16}H_{11}NO$ and $C_{16}H_{13}NO_2$ to those two compounds. The difference in percentage composition between the C_{15} and C_{16} formulæ is very slight, affecting chiefly the hydrogen, which was found too high in the earlier analyses.

102. "*The Action of Salicylic Aldehyde on Sodium Succinate in presence of Acetic Anhydride.*" By GIBSON DYSON, Demonstrator of Chemistry, Normal School of Science, South Kensington.

By heating a mixture of 10 grms. sodium succinate, 15 grms. salicylic aldehyde, and 13 grms. acetic anhydride, in a sealed tube for 40 hours, at a temperature of 140° C., the author obtained a substance having the composition $C_{18}H_{10}O_4$, to which he has given the name "*Dicoumarine.*" It is an extremely stable body, insoluble in water, ether, alcohol, benzene, and chloroform, but soluble to a slight extent in hot glacial acetic acid, from which it separates on cooling in acicular crystals. It dissolves in a hot solution of sodium hydrate, but is reprecipitated unchanged on addition of an acid.

By acting on its alkaline solution with sodium amalgam, hydrodicoumaric acid, $C_{18}H_{14}O_5$, is formed. This acid, when heated at 130° C., gives off a molecule of water, yielding an anhydride (hydrodicoumarine) $C_{18}H_{14}O_4$ (m. p. 256° C.); hydrodicoumaric acid also combines with bromine to form addition products. By further reduction of hydrodicoumaric acid, an acid having the composition $C_{18}H_{18}O_6$ is obtained. This *dihydrocoumaric acid* yields an anhydride, $C_{18}H_{14}O_4$, melting at 222—224° C.

Zwenger (*Annalen*, *Sup.* 8, 32), by reducing a saturated alcoholic solution of coumarine with sodium amalgam, obtained hydrocoumaric acid, $C_{18}H_{18}O_6$, which yields an anhydride, $C_{18}H_{14}O_4$, melting at 222° C. The constitution assigned by Zwenger to his acid is the same as that given by the author to dihydrocoumaric acid; the two acids are, however, not identical. Both acids yield an anhydride $C_{18}H_{14}O_4$, melting at 222° C. It is probable that we have here another case of isomerism similar to that observed by Perkin to exist between α- and β-coumaric acid.

103. "*The Reduction of Nitrites to Hydroxylamine by Hydrogen Sulphide.*" By E. DIVERS, F.R.S., and T. HAGA.

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Pyridine and quinoline form the additive compounds, $2C_5H_5N \cdot SiCl_4$, $2C_9H_7N \cdot SiCl_4$.

At the next meeting, on December 2nd, there will be a ballot for the election of Fellows, and the following Papers will be read:—"Bismuthates," by M. M. P. Muir. "The Action of Inorganic Compounds on Living Matter," by James Blake, M.D. "Morindin and Morindon," by T. E. Thorpe, F.R.S., and A. T. Greenal.

NOTICES OF BOOKS.

Heroes of Science: Physicists. By WILLIAM GARNETT, M.A., D.C.L. London: Society for Promoting Christian Knowledge. New York: E. and J. B. Young and Co.

HEROES are generally taken to be men who have distinguished themselves by acts of personal bravery when on the battle-field, or in other circumstances of great danger. But there is another class of heroes not often so well known to the public, and amongst this class heroes of science are most certainly to be found,—men who have devoted their whole lives with untiring energy to the solution of the problems and secrets of Nature, so that the world at large might derive benefit therefrom.

The book which now lies before us gives, in a most interesting manner, the lives of some of the more celebrated workers in chemical and electrical science, such as Benjamin Franklin, Henry Cavendish, Michael Faraday, &c.

The biography of Benjamin Franklin shows what a marvellous capacity he had for devoting himself thoroughly to quite different subjects when the necessity arose: thus we find him as a printer, a soldier, a politician, and a scientific experimenter of the first rank.

One of the drawbacks to Henry Cavendish was his extreme shyness, and his aversion to female society of any kind; he was entirely wrapped up in his experiments, and had comparatively little communication with the outside world. Dr. Wilson sums up Cavendish's view of life as follows:—

"His theory of the universe seems to have been that it consisted *solely* of a multitude of objects which could be weighed, numbered, and measured; and the vocation to which he considered himself called was to weigh, number, and measure as many of these objects as his allotted three score years and ten would permit. This conviction biassed all his doings—alike his great scientific enterprises and the petty details of his daily life. *Panta metro, kai arithmo kai stathmo* was his motto, and in the microcosm of his own nature he tried to reflect and repeat the subjection to inflexible rule and the necessitated harmony which are the appointed conditions of the macrocosm of God's universe."

But the hero of science who stands out far beyond his fellows is Michael Faraday, and Mr. Garnett very justly remarks that "The work of Michael Faraday introduced a new era in the history of physical science," and in this biography we cannot fail to be struck with the originality, simplicity, and penetration of this king of experimenters, so admiraby set forth in this book.

The other biographies are equally interesting and instructive, but space will not allow us at present to enlarge on them.

Twenty-second Annual Report of the Alumni Association; with the Exercises of the Sixty-fifth Commencement of the Philadelphia College of Pharmacy. Philadelphia. 1886.

THIS Report contains a great variety of matter, some of which is of general importance. In the opening address of Mr. C. D. Lowe we find reference to a curious specimen of nomenclature. "A lady wanted to purchase some dog oil." This strange name is not italicised or put in quotation marks, but stands as an ordinary and intelligible term. But for the incidental remark in a following sentence, "commonly called sweet oil," we should have suspected that this barbarous term might mean Dippel's *oleum animale*."

A lecture delivered by Prof. F. Woodbury, M.D., on "Things Material and Immaterial," contains passages which in the eyes of most scientific men will seem to border upon the heretical. What shall we say of the following quotation from Prof. Tyndall?—"Inasmuch as it is still in its hypothetical stage, the ban of exclusion ought to fall upon the doctrine of Evolution." Surely such an utterance comes with scant grace from him who delivered the memorable "Belfast Address"; scantier still if we remember how many of the evidences which at that date were still hypothetical have since been absolutely demonstrated.

Dr. Miller commented very needfully on a label calculated to do much mischief:—"I saw an ounce bottle of sulphate of morphine with a label the upper portion of which said sulphate of morphine in tolerably large letters, then there was the usual vignette in the centre, and below the vignette it read 'Quinine Manufacturing Company,' and the word, in large letters, 'Quinine' immediately underneath the sulphate.

The law of negligence, as it relates to compounding medicines, is expounded at some length by W. E. Tolan, of the Philadelphia Bar. With one decision which he quotes we cannot for one moment agree. The defendants in a certain case sold antimony sulphide for manganese peroxide. The purchaser used it along with potassium chlorate for generating oxygen, and was severely injured by the explosion which ensued. Yet the defendant was held free from blame. This decision, as it was pointed out in the discussion, is the more inequitable since the preparation of oxygen along with potassium chlorate is perhaps the most common use to which manganese dioxide is put when bought in retail quantities.

Dr. J. J. Reese, Professor of Medical Jurisprudence and Toxicology in the University of Pennsylvania, gave a very interesting lecture on "Some Points in Toxicology." He brought forward a point which may in some cases complicate toxological investigations, and of which an instance had come under his notice. Some person dies a natural death. An evil-minded being, having access to the body after death, introduces a solution of some poison into the stomach through a tube. He allows a couple of months to pass over, and then spreads a report that there has been foul play. The body is exhumed, and the poison is detected in the organs examined. The motive is, of course, to bring into condemnation some person who has been in the company of the deceased prior to or during his last illness. It has been found, by direct experiment upon the bodies of dead dogs, that arsenic, tartar emetic, and corrosive sublimate thus introduced may traverse the coats of the stomach, and may, after the lapse of three, six, or eight weeks, be detected in the liver, the kidneys, and the heart. Christison admitted the possibility of this crime.

In the subsequent discussion mention is made of the fact that arsenic (doubtless arsenious acid) is fifty times more soluble if boiled in water than if treated with cold water. In this manner about 600 persons are said to have been poisoned in Vienna.

A Set of Chemical Labels for the Laboratory, Alphabetically Arranged. By PHILIP HARRIS and Co., Bull Ring, Birmingham.

THESE labels are printed in a very bold, distinct type, each having the empirical formula above the name, and below it the rational formula. Besides labels for the ordinary reagents, there are others for the principal

standard solutions used in volumetric analysis, blanks being left for the value of a c.c. and for the number of grammes per litre of the solid substance.

This set of labels will be found decidedly useful in the laboratory.

CORRESPONDENCE.

AN EXAMINATION PUZZLE.

To the Editor of the Chemical News.

SIR,—The question stated below was set at an examination in one of the Government Departments upon a Laboratory Course on the analysis of substances containing only one metal and one acid. Can any of your readers kindly tell me how *x* could have misconducted itself in the manner stated. The italics are mine.—I am, &c.,

A.X.

November 22, 1886.

A substance, *x*, dissolves in water and the solution is *alkaline* to test-paper; it gives no precipitate with hydrochloric acid and sulphuretted hydrogen, but a flocculent colourless precipitate with *ammonia*, which is unaltered by ammonium sulphide. The filtrate from this precipitate gives no further precipitate with ammonium carbonate, sodium phosphate, or *platinum chloride*. What substances behave like *x*, and how can you distinguish between them?

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 19, November 8, 1886.

Thermic Researches on the Reactions between Ammonia and the Magnesium Salts.—M. Berthelot.—The association of a metallic oxide such as magnesia with ammonia gives rise to the formation of a complex alkali, analogous to the oxides of tetramethyl-ammonium, possessing an energy superior to that of the metallic oxide, and comparable to that of the most powerful alkalies.

Report Presented on behalf of the Chemical Section on the Researches of M. Moissan relating to the Isolation of Fluorine.—M. Debray.—This report gives a summary of the history of fluorine from the first recognition of its nature by Davy in 1813. It describes the attempts at its isolation made by Davy himself, by the Brothers Knox, and by Louyet, who fell a victim to the poisonous fumes which he inhaled. Faraday, Gore, and Frémy took up the problem in succession, but it was not ultimately solved until M. Moissan took it in hand. The report describes his experiments, which have already appeared in the CHEMICAL NEWS, and cites the arguments by which he shows the nature of the gas obtained. The Section concludes, after witnessing the repetition of his experiments, that the gas obtained by the electrolysis of anhydrous hydrofluoric acid is certainly fluorine. They remark that the history of this body enters thus into a new phase.

General Methods of Crystallisation by Diffusion. Ch. E. Guignet.—The author has undertaken a generalisation of the beautiful experiments of the elder Becquerel on the slow actions set up between two liquids separated by a membrane, a porous septum, or even a glass tube provided with a slit or a capillary orifice. He examines the physical and chemical actions of a solid diffusing itself into a liquid and the corresponding actions of one liquid diffusing itself into another.

Determination of the Neutralisation-Heats of the Malonic, Tartronic, and Malic Acids. Remarks on the Neutralisation-Heats of the Acids Homologous to Oxalic Acid and of the corresponding Hydroxylated Acids.—MM. H. Gal and E. Werner.—The authors give their results in the form of tables, from which it would appear that the neutralisation-heats of the homologous bibasic acids included in the tables decrease as the molecular weight increases. If we compare the development of heat produced in the neutralisation of oxalic, malonic, tartronic, succinic, malic, and tartaric acids with that furnished by the hydroxylated acids derived from them we see that the introduction of OH into oxalic, malonic, and succinic acids reduces their total neutralisation-heat by about two calories.

Synthesis of Conicine.—The author obtains a base, *a*-propylpyridine, which has the same properties, physical, chemical, and physiological, as conicine.

On Chemical Transformations induced by Solar Light.—E. Duclaux.—The author finds that solar light, aided sometimes, though not always, by solar heat, acts in the same manner as microbia, and, like them, rearranges complicated chemical molecules into simpler groups. Water and carbonic acid, products of combustion, form always parts of these groupings; but there are others, yet combustible and relatively stable under the influences which produce them, which appear as the residues, temporary or final, in the solar combustion of a great number of different bodies. These residues of solar action are almost always the same as the residues, temporary or final, of the action of the ferments.

A Novel Means of Preventing Secondary Fermentations in Industrial Alcoholic Fermentations.—U. Gayon and G. Dupetit.—The authors effect this object by the addition of minute doses of the salts of bismuth.

The Alcoholic Fermentation of Dextrine and Starch.—U. Gayon and E. Dubourg.—It is well known that the *Saccharomyces* are without action upon solutions of dextrine and upon starch-paste. A species of *Mucor*, however, has the double property of fixing water upon dextrine, and even upon starch, and causes these bodies to ferment. It does not invert cane-sugar or transform it into alcohol.

Reduction of Copper Sulphate during Fermentation.—H. Quantin.—Copper present in the must of grapes (added, *e.g.*, as sulphate in the treatment of mildew) is eliminated as sulphide, and in that state is not attacked by the must.

Justus Liebig's Annalen der Chemie. Vol. ccxxxvi., Parts 1 and 2.

Communications from the Physico-Chemical Laboratory of the University of Leipzig, comprising:—

Condensation of Thio-Urea and Acetacetic Ether.—Reinhold List.—The author examines the action of thio-urea upon acetacetic ether, the formation of thio-methyl-uracil, its derivative salts and ethers, and finally his experiments made to ascertain its constitution.

Nitro-derivatives of Methyl-uracil.—Albin Köchler.—It appears that strong nitric acids converts methyl-uracil into nitro-uracil carbonic acid, which gives off carbonic acid, forming nitro-uracil. On treating nitro-uracil carbonic acid in an alcoholic solution with hydrochloric acid there is formed nitro-uracil carbonic ether. Tin and hydrochloric acid reduce nitro-uracil carbonic acid to amido-uracil carbonic acid. Nitro-uracil carbonic ether is reduced by tin and

hydrochloric acid to a mixture of amido and oxyuracil carbonic ether. On saponifying this product there is obtained amido-uracil carbonic acid. The latter passes by splitting off carbonic acid into amido-uracil. Methyl-uracil is converted by fuming nitric acid and strong sulphuric acid into nitro-uracil.

New Mode of the Formation of Dibrom- and Dichlor-barbituric Acids.—R. Behrend.—This memoir does not admit of useful abridgment.

Communications from the Chemical Laboratory of the University of Würzburg.—These comprise papers by L. Knorr on synthetic experiments with acet-acetic ether; by E. Fischer, on the synthesis of indol-derivatives, and on indols from phenyl-hydrazine; by Jos. Degen, on indoles from methyl-phenyl-hydrazine; by Anton Roder, on indoles from met-hydrazine benzoic ether; by Adolf Schlieper, on indoles from β-naphthyl-hydrazine; by Carl Bulow, on phthalyl-acetacet ether and on certain compounds of phenyl-hydrazine; and by E. Fischer, notices on the hydrazines.

On the so-called α-Thiophenic Acid and its Relation to the two Normal Carbonic Acids of Thiophene.—Victor Meyer.—The two acids are quite distinct in their properties, their differences being constant and not removable by purification or transformation. All the derivatives of the two acids agree absolutely in their chemical properties and might be regarded as identical in the ordinary sense, only that every derivative from the α-acid yields α-acid on re-conversion, whilst every β-derivative yields the β-acid.

Communication from the Chemical Institute of the University of Bonn.—J. Bredt.—A memoir on acetyllävulenic acid and on the constitution of the γ-ketonic acids.

Journal für Praktische Chemie.
New Series, Vol. xxxiv., Parts 4 and 5.

Action of Aluminium Bromide upon Ethylene and the Bromides of the "Limit Alcohols."—G. Gustavson.—The author describes the preparation and properties of hydrocarbon-aluminium bromide, the action of ethyl bromide upon aluminium bromide; the behaviour of brom-ethyl upon hydrocarbon-aluminium bromide; the action of primary and secondary propyl-bromide upon hydrocarbon-aluminium bromide and aluminium bromide and the behaviour of isobutyl-bromide with the same bodies.

Communications on Germanium.—Clemens Winkler.—A very full account of the occurrence, properties, and combinations of this new element.

Contributions to a knowledge of the Hydrated Sodium Sulphides.—C. Göttig.—On treating a moderately concentrated solution of sodium hydroxide in strong alcohol with hydrogen sulphide there is formed, first, the compound $Na_2S + 6H_2O$; then when the solution is poorer in water $2Na_2S + 11H_2O$, and, under certain circumstances, the sulphide $Na_2S + 5H_2O$; all which substances disappear again on the prolonged action of hydrogen sulphide.

The Volatile Fatty Acids occurring in Commercial Lupuline.—J. Ossipow.—The author traces butyric acid, one of the two valerianic acids, or isopropyl-acetic acid.

Revue Universelle des Mines, de la Metallurgie, &c.,
Vol. xx., No. 1, July and August, 1886.

Note on the De-incrustation of Belleville Steam-Boilers—C. Quéhant.

Corrosion and Incrustation of Boilers; Protection by Zinc.—Louis Canon.

In both these papers the use of metallic zinc is recommended.

Determination of Nitrogen in Coal and Coke.—From the *Zeitschrift f. Anal. Chemie.*

Electrolysis in Metallurgy.—A. Zoppetti.—The conclusion of a voluminous memoir not capable of useful abstraction.

Volumetric Determination of Sulphur in Sulphides which can be Decomposed by Hydrochloric or Sulphuric Acid.—F. Weil.—From the *Comptes Rendus.*

The Kjeldahl Process for the Determination of Nitrogen in Organic Matter.—L. L. de Koninck.—A summary of the Kjeldahl process and of the modifications in it which have been proposed.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 8, August, 1886.

Discovery of a New Element.—Clemens Winkler.—Already noticed.

MISCELLANEOUS.

Cantor Lectures.—The first course of Cantor lectures at the Society of Arts is announced to be on the "Principles and Practice of Ornamental Design," by Lewis Foreman Day. The first lecture, on November 29th, will deal with the anatomy of pattern. The subject of the second and third lectures will be the distribution of ornamental design and the fitness of ornamental form respectively, while the fourth and concluding lecture will will treat of natural form and ornamental treatment. These lectures are open to members of the Society of Arts, who have also the privilege of introducing friends. A limited number of tickets are available for the use of art-workers, actually employed in any handicraft connected with the decorative arts. Application for them should be made to the secretary of the Society.

What we Drink.—On Friday last Mr. E. Godwin Clayton gave a lecture, at St. James's Hall, entitled "What we Drink." After commencing with some general observations and setting forth the merits and demerits of various kinds of drink, he gave an interesting sketch of the history of wine, and stated that the natural amount of alcohol in wine was 10 per cent, but some, such as sherry and port, contained as much as 20 and 21 per cent. The least fortified wine is Madeira, which is very rich and of excellent flavour; in fact the lecturer stated that Madeira is the only wine that can now be relied upon for absolute purity; and curiously enough, in spite of this, although the population in England since 1819 has nearly doubled, the importation of Madeira has fallen from 750,000 gallons in 1819 to about 100,000 gallons in 1885. Tea he regarded as very refreshing, although we think that when drunk in large quantity, as is the present custom, it has almost as bad an effect on some persons as an excess of alcohol has on others. The habitual use of spirits is no doubt very prejudicial, and we think most people will agree with Mr. Clayton that the most refreshing and least hurtful drink for the general mass of English people is a glass of beer.

MEETINGS FOR THE WEEK.

MONDAY, 29th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Principle and Practice of Ornamental Design," by Lewis Foreman Day.
TUESDAY, 30th.—Institution of Civil Engineers, 8.
—— Royal, 4. (Anniversary).
WEDNESDAY, Dec. 1st.—Society of Arts, 8. Adjourned Discussion on Paper on "Sewage Disposal," by Dr. C. Meymott Tidy.
—— Geological, 8.
THURSDAY, 2nd.—Chemical, 8. Ballot for the Election of Fellows. "Bismuthates," by M. M. P. Muir. "The Action of Inorganic Compounds on Living Matter," by James Blake, M.D. "Morindin and Morindon," by T. E. Thorpe, F.R.S., and A. J. Grimsal.
—— London Institution, 6.
FRIDAY, 3rd.—Geologists' Association 8.

THE CHEMICAL NEWS.

VOL. LIV. No. 1410.

TREATMENT OF PHOSPHORIC CRUDE IRON IN OPEN HEARTH FURNACES.*

By J. W. WAILES.

If the treatment of phosphoric pig-iron be measured in its importance by the quantity of this material, compared with that which may be called for practical purposes non-phosphoric iron, it will possess an importance in Europe ten to twelve times greater than that of a process only calculated to deal with the purer kinds of crude metal; for it is roughly estimated that the deposits of ore yielding phosphoric pig-iron exceed by about ten or twelve to one those yielding non-phosphoric pig.

As all pig-iron, more or less, contains phosphorus, it will be necessary to draw a line between this phosphoric iron and what regarded as non-phosphoric iron. This line has been drawn within comparatively narrow limits by the great steel-making processes of Bessemer and Siemens prior to the introduction of the basic process of Thomas and Gilchrist.

The effect of phosphorus in wrought-iron and steel is to cause "cold-shortness," *i.e.*, brittleness at ordinary temperatures. The amount of phosphorus that can be allowed in steel depends largely on the purpose for which the metal is intended, and on the amount and relative proportions of other elements the steel may contain. Hard steel for certain purposes has been found to answer well with 1 per cent, or even a little more phosphorus; but it is generally allowed that where soft and ductile metal is wanted the less phosphorus it contains the better.

As the great steel-making processes already alluded to remove very little of any phosphorus, pig-iron with not more of this element than could be allowed in the finished steel had to be selected. So that a line may be drawn at pig-iron with more than 1 per cent of phosphorus; though steel produced from such iron could only have a very limited consumption, and, as a matter of fact, half this quantity of phosphorus is quite as much as manufacturers care to deal with.

By the reducing process of the blast-furnace, the phosphoric acid found in the ore finds its way into the pig-iron, and there appears as little prospect as ever of producing non-phosphoric iron from phosphoric ore (to any commercial extent) as ever there was.

This part of the question, however, is not one coming within the scope of this paper; it is only intended to begin where the blast-furnace leaves off, and to consider the treatment of the crude metal as it is produced.

The whole of the pig-iron produced in the Midland Counties, unless from ore imported, contains more phosphorus than could be allowed in marketable steel. So that it is to some process with the power to eliminate phosphorus that the iron manufacturer of the Midlands must look in the future, as he has done in the past, for his occupation.

The introduction of the basic Bessemer process rendered the removal of phosphorus from pig-iron in its conversion into steel a thing of certainty and great commercial utility. It is not, however, contemplated to deal with this branch of the subject, but to confine the necessarily brief remarks to the open hearth mode of treatment.

Although, as has been stated, the great steel process required—before the introduction of the basic process—crude iron free, or nearly free, from phosphorus, the puddling process has for over a century converted phosphoric pig-iron into wrought-iron, and in this conversion has removed 80 to 90 per cent of the phosphorus it contained.

At the head of the list must stand the well-known process of puddling, and it is only with the view of comparing it with another and really very similar process that it will here receive a brief description.

Diagram No. 3, fig. 1*, shows a longitudinal section of a common puddling furnace most generally in use in the Midland district, and fig. 2 an elevation of the same. In fig. 1: A, the fire grate; B, the hearth; C, the flue to the chimney. The process is as follows: The hearth (B) is first "fettled," fitted or formed with oxide of iron, and the pig-iron in quantities of from 4 to 5 cwts. charged in through the door, which is then closed, and the heat forced as rapidly as possible, the damper being kept open. In from 30 to 40 minutes the iron is melted, and the operation of puddling begins. The puddler takes a "rabble" (an iron bar with a paddle-shaped end), about 2 inches broad and bent at the end at right angles to the staff for a length of about 5 inches. The oxide of iron from the bottom and sides of the hearth melt up with the molten pig-iron, and the puddler thoroughly agitates it, so as to wash the iron with the fluid oxide. Ebullition commences, and the stirring is continued. A change now begins to be perceptible, the iron thickens and appears crumbly, shows signs of separating itself from the fluid oxide, and forming on the bottom. Heat is checked by lowering the dampers, and the spongy iron worked together and formed, with much skill and exertion, into balls of the desired size.

With a pair of tongs these balls are dexterously lifted from the furnace and conveyed to a hammer or press, where the cinder is expelled and the ball is forged into a rectangular block and, at the same heat, passed through rolls to form it into a bar of any required size. When cold, the bar is cut up and piled for further rolling.

The operation of puddling, which takes from 30 to 40 minutes after the pig-iron is melted, is one demanding very great exertion, the puddler in hot weather working stripped to the waist and in a bath of perspiration.

It is reported that a celebrated iron manufacturer has said that only fools would become puddlers; but this certainly is not true in the Midland Counties. The operation requires considerable skill and attention, and, as a rule, the puddlers are a class deserving both sympathy and respect. The work is divided between two men, a first and second hand, the latter taking the earlier part of the operation. Six heats is the usual turns work.

The chemical reactions that take place during the conversion of crude iron into wrought-iron will readily be gathered from a glance at diagram No. 2. In the changes shown, the time is placed in the left-hand column and remarks in the one opposite. The various elements are shown in the same colours in all the diagrams of both iron and steel reactions, viz., carbon, brown-silicon, yellow, sulphur, blue, phosphorus, red, manganese, purple.

Innumerable modifications of the puddling furnace, and the means of carrying out the operation of puddling, have from time to time come to the front, and met with varying success. These modifications appear to divide themselves into two principal groups.

1. Where the manual labour is superseded by the application of mechanical motion to the rabble.
2. Where it is sought to obtain the same end by imparting rotary motion to the melting chamber of the furnace.

In both these plans, and indeed in all the modifications of the puddling furnace, the great difficulty underlying everything has been the want of heat. Puddling is really

* A Paper read before the British Association, Birmingham Meeting, Section B.

* These have reference to the diagrams exhibited during the reading of the paper.

of sufficient heat. When the molten crude iron has parted with a large portion of its alloys, the heat in the puddling furnace is insufficient to hold the purified iron in a molten condition, and it therefore becomes necessary to take it from the furnace in a spongy state.

Having briefly sketched the puddling furnace, and given a few of its reactions, a comparison can readily be made with the process now to be described. Diagram No. 3 represents a plan and elevation of the "Batho Furnace," an improved form of the Siemens regenerative furnace.

Generally considered, the principal character of this invention is the getting rid of the idea of a furnace as a building.

A simple mechanical contrivance is substituted for the mass of masonry, bound together with iron stays and props. In the contrivance before you four wrought-iron cases form the regenerative stoves and a fifth circular case the melting vessel. The stoves are connected to the vessel by means of pipes, lined with heat-resisting material. This furnace, or apparatus, has been described by Mr. F. W. Dick, of the Steel Company of Scotland, in a paper read before the Iron and Steel Institue at the Chester meeting. The stove cases are lined with a course of bricks, backed up with burnt ashes; this material forming a good non-conductor, and having the further important recommendation of being cheap.

There is much advantage in this separate system of regenerator. The very nature of the regenerative furnace demands that these shall be continually heated and cooled, causing corresponding expansion and contraction, often producing in the old form of regenerative furnace (where the regenerators are built in a solid block of masonry) cracks, allowing the gas and air to mix, and causing great trouble and loss.

In keeping these chambers tall, and placing the chequer bricks pretty open, the heat is collected and given back with as little obstruction to the currents as possible, thus securing the most rapid action of which the furnace is capable.

The melting vessel is lined with basic material, and covered with a lid of silica bricks, enclosed in a strong iron ring. This lid is suspended from girders, and does not rest on the sides of the melting vessel, and by means of small rollers can be run back so as to open the vessel when repairs are necessary.

An aperture through the side of the vessel allows the inflow of gas, and directly over this the column of air flows through an opening in the lid, deflecting the gas, which acts like a blowpipe on the material under treatment. Combustion thus obtained is very rapid, and, as the lid has only to resist the radiated heat, it is not cut or melted, as is the case when the flame breaks against any part of a silica lining.

Any contact between the acid lid and the basic sides of the melting vessel, at the heat necessary to purify the charge, would result in the rapid destruction of the parts coming together: a small space, however, is found quite sufficient to overcome any difficulty of this kind, and it is only necessary to keep the two materials ¼ of an inch apart.

The composition and application of the basic lining to the vessel is as follows:—

Lining is composed of highly burnt dolomitic limestone, called—

Shrunk lime	about	77	parts by weight.
Retort carbon	,,	12	,, ,,
Fine wire cuttings ..	,,	6	,, ,,
Oxide of iron	,,	5	,, ,,

This material is ground up to a moderately fine powder, and mixed with sufficient tar to form it into a plastic mass, to allow of its being rammed round a mould placed in the interior of the chamber. The casing of the melting vessel is perforated with small holes about 6 inches apart, and the wire spread out to hold the lining to the casing securely.

Basic lining is not easily obtained in a form allowing of its being used as a building material. It will, however, be easily seen, that in the form of the apparatus under consideration the difficulty attending the application of the lining is reduced to a minimum.

The use of the wire as a mixture in the lining may be best explained by stating that it is used for very much the same reason that hair is used in plaster; it prevents the plaster cracking and falling from the walls.

The melting vessel may be made of any capacity. The one in use at the Patent Shaft and Axletree Co.'s Works takes a charge of 5 tons, but vessels up to 8 or 10 tons will be adopted by this Company in future.

One advantage of considerable importance in the form of the apparatus is that heat may be urged as fully as possible as soon as gas is turned on, without fear of damage due to rapid expansion; the slow annealing necessary in the ordinary form of furnace is of no importance.

The mode of working is perfectly simple, and is as follows:—Full heat being obtained, which may be done in twelve or eighteen hours from the time gas is first turned on, lime and oxide of iron are put on the bottom and sides of the hearth of the melting vessel, and the charge of any kind of scrap and phosphoric iron put in, and the door closed. The charge is melted in from three and a half to four hours, and a slag formed by the melting oxide of iron and lime, and reaction commences. This is kept up by the occasional addition of ore and lime, till the boiling ceases in about eight hours after the charge is put into the vessel. Samples are taken during the latter part of the operation, hammered, and quenched in water. These samples are then bent or broken. A little experience soon enables the operator to determine the condition of the charge. The addition, at the end of the charge, of a little pig-iron containing a good percentage of carbon, has the effect of again starting a rapid boil, which lasts for twenty to thirty minutes. This plan produces good results, and removes the traces of phosphorus.

Manganese is thrown into the bath, and the charge tapped in the usual way.

From seven and a half to ten hours are occupied over the charge from first to last, probably a little more time than would be taken over an acid charge.

In performing any chemical operation the cleanliness of the vessel employed is a thing of great importance, and the purification of phosphoric iron in this vessel is no exception. Especially is it important to keep the vessel free from any acid matter. This important condition is obtained by keeping all acid lining entirely out of the vessel, and directing the flame away from the lid.

In comparing the two open hearth means of purifying phosphoric iron, it will at once be seen that the latter will accomplish the desired end far more thoroughly than the former, for the simple reason that the more perfect the heat the more perfect the reaction. To quote Mr. Stead, from a paper already referred to, "The conditions required for the elimination of phosphorus are the same in every dephosphorising process. In fact, the law is established that dephosphorisation is always effected when fluid iron is brought into contact with an oxidising base, which must be in excess and fluid."

This being so it follows, as a matter of course, that the more perfectly the conditions can be fulfilled, the better—or at any rate the purer—the resultant.

The table of reactions shown on diagram No. 4 sufficiently explains the process, and comparison can be at once made with the reactions obtained under similar conditions in the puddling furnace, shown by the tables, diagram No. 2.

It is quite certain that, by the process just described, ingot iron of the most perfect quality can be readily pro-

duced from crude iron containing a very high percentage of phosphorus. Indeed it is a question in the writer's mind if the amount of phosphorus in the pig is a thing of any moment, any more than carbon or silicon under other conditions.

The normal mechanical condition of this ingot iron—and by this is meant when it is as pure as can be made—gives a breaking strain of 24 to 27 tons per square inch, with an elongation in 6 inches of 25 to 30 per cent, and a reduction of area of 50 to 70 per cent.

In the Bingley Hall Exhibition the Patent Shaft Company show a small 6-inch ingot that has been drawn down at one end under the hammer. This will sufficiently serve to show the quality of this metal in regard to what may be called "hot test." It is an advantage to work the charge from the commencement with manganese, either in the pig or added as spiegel or ferro-manganese.

Time will not allow more than a few principal points being considered; but id comparing ingot metal with the bar obtained from puddling, it must not be forgotten that the imperfection of the latter has in it a point of no small practical value.

The fibres of the pure soft iron, arranged amongst the entangled slag in the puddled bars, prevent what is certainly a weakness in the purer homogeneous metal.

A patent fagotted axle—such as those made by the Patent Shaft Company, where the purest crude iron obtainable is used, and process of manufacture watched, and the numerous bars which go to form the fagot selected with great care—such an axle, if superficially cut with a sharp tool and then subjected to the shock of a falling weight, will bend and allow the fibre to open to the depth of the cut only.

If, however, any steel bar, no matter how good, be treated in the same way, complete fracture is the inevitable result.

It was not intended to consider in this paper any view of the pneumatic process of treating phosphoric iron (the basic Bessemer process). One word, however, may not be out of place. The oxidising base needed to eliminate the phosphorus in the Bessemer converter has to be obtained by the oxidation of part of the metallic charge. In the open hearth treatment the oxide is put in the vessel as oxide, and although the conditions may and must be the same in every dephosphorising process, the means employed in creating these conditions differ widely.

Periodically the users of soft steel receive a shock—a mysterious failure is reported and certain papers are full of articles and letters on the subject—a boiler-plate has cracked like a sheet of glass; chemical analysis shows—what must be regarded from that point of view—satisfactory material, or, perhaps, very pure material.

It is not the purpose of this very sketchy paper to advance any theory on this important point, but it is generally revealed on investigation that these failures occur in steel of one class, viz., very soft steel made by the Bessemer process, steel where the process has been pushed to its utmost limit and oxidation has been greatest.

That this is debateable ground the reports of many discussions fully testify.

In considering the mechanical properties of soft homogeneous iron, it appears only fair that this side of the question should be touched upon.

Ingot iron from the open hearth basic furnace in England has not had the test of time that Bessemer ingot iron has had, so that it is not just to say that it does not possess this element of uncertainty; but from all the opportunities the writer has had of forming an opinion on the subject, a good chemical composition may be relied upon for a correspondingly good mechanical result.

The following is a fairly typical charge made from 75 per cent of Staffordshire white and mottled cinder pig iron—containing 2·8 per cent of phosphorus—and 25 per cent of steel scrap :—

Carbon	0·12 per cent.
Silicon	nil ,,
Sulphur	0·02 ,,
Manganese	0·43 ,,
Phosphorus	0·028 ,,

This charge rolled into ¾ inch round bars gave a tensile strength of 25·7 tons. An elongation of eight inches of 26 per cent and a reduction of area at point of fracture of 68 per cent.

That the old puddling process is dying full of years and honours, after having wrought mighty things for the civilized world, is a fact beyond all doubt. What particular process shall take its place in the largest degree time alone will determine. For the process just described, it may be said that it hardly supersedes puddling, it only renders the manual labour unnecessary, and in another way does the work far more perfectly.

THE COMPOSITION OF HYDRATED SALTS.

By SPENCER U. PICKERING and P. G. SANFORD.

Some short time ago Maumené (CHEMICAL NEWS, liii. 146) drew attention in these columns to the views entertained by him concerning the proportions in which elementary substances combine. The formulæ which he would have us assign to various substances are far more complex than those which chemists have hitherto been willing to accept. According to him potassium peroxide is $K_{16}O_{39}$, sodium peroxide $Na_{16}O_{23}$, &c.; potassium hydrate $(K_2O)_9(H_2O)_{47}$; and the conclusions which he draws from analyses of the hydrates of potassium, &c., he would extend to the hydrates of all salts, and deny that the water molecules present in them bear any simple numerical relation to the molecules of the salt (*Bull. de la Soc. Chem. de Paris*, December, 1885). Although these views are not likely to find a very ready acceptance amongst chemists, the careful analytical results on which they are founded must receive some explanation before they can in reason be rejected.

The facts which he signalises are, moreover, in accordance with our general experience. Few who have had occasion to prepare any hydrated metallic salts can have failed to observe the difficulty—and often, indeed, the impossibility—which there is in obtaining them with the theoretical percentage of water. To take, as an instance, the various salts prepared by Thomsen for his calorimetric determinations: out of fifty-seven different specimens* (*Thermo-chem.*, iii., 199) ten only contained the theoretical quantity of water, seven contained less water than their formulæ necessitated (on an average 0·08 H_2O less), while as many as forty contained more water than they should have, this excess amounting on an average to over 0·1 H_2O.

The explanation of this non-accordance of actual and theoretical results is, we believe, very simple. In the course of preparing several normally anhydrous salts, we have been much struck by the extent to which accidentally enclosed water is retained by them, in defiance of fine powdering and prolonged heating, at temperatures considerably above 100° C.

We have determined the amount retained in several instances by the salts: (1) after they had been exposed over sulphuric acid till constant in weight; (2) after treating at 100° till constant; (3) after a similar treatment at 200°. The salts consisted in most cases of preparations which had been passed through a sieve with thirty meshes to the inch, and which would not pass through one with sixty meshes to the inch; in one case finer sifted samples—(1) that passing through sixty but not through

* This number does not include some of the salts of the rarer metals where the discrepancies observed were very large.

Water Contained in Crystals.

Salt.	Coarse Sample after drying— At 200° C.	At 100° C.	Over H_2SO_4.	Medium sample after drying over H_2SO_4.	Fine Sample after drying over H_2SO_4.
Sodium chloride	0·706 / 0·615 } 0·660	0·738 / 0·648 } 0·693	0·770 / 0·683 } 0·726		
Ditto, another sample ..			0·608 / 0·675 } 0·641	0·349 / 0·303 } 0·326	0·228 / 0·205 } 0·216
Sodium chloride, crystallised at 100° C.			0·721 / 0·769 } 0·745		
Sodium chloride, crystallised at low temperature—					
Crystals, large			0·310		
„ small			0·223		
Potassium chloride			0·749 / 0·761 } 0·755	0·337 / 0·303 } 0·320	0·321 / 0·343 } 0·332
Potassium chlorate			0·334 / 0·368 } 0·351		
Potassium sulphate			0·131 / 0·0904 } 0·1107		
Potassium nitrate..	Nil	Nil	Nil		

ninety, and (2) that passing through ninety—were also examined.

The results are given in the accompanying Table, and show how considerable may be the amount of water thus mechanically retained within the crystals of a salt.

What occurs with these normally anhydrous salts will undoubtedly occur in the case of hydrated salts also, and will fully account for the water percentage obtained on analysis being generally above the theoretical amount, especially when it is remembered that in very few cases is it possible to dry a hydrated salt previous to analysis in as effectual a manner as in even the least dried samples here taken. It must be owned that we have no means of determining the amount of combined water in a hydrated salt, and we can therefore draw no conclusions from any analytical results which are obtained.

In the case where the water present was greatest (potassium chloride) it amounted to as much as 0·76 per cent, or 0·03 H_2O. It varies considerably with the manner in which the sample is prepared. The specimen crystallised from a hot solution contained more water than that crystallised in the cold: this is probably due not to the direct influence of temperature, but to the former crystals being formed less regularly, and consequently offering more internal spaces in which some liquid may be enclosed.

The water contained varies to a very large extent, as might be supposed, with the nature of the salt. In the case of potassium nitrate it is practically *nil*. The same variation will undoubtedly exist with hydrated salts, and in some cases (though these are probably somewhat exceptional) no enclosed water may be present, and it will therefore be possible to obtain the hydrate with the theoretical percentage of water. This would appear to be the case with the sulphates of magnesium, copper, &c.

THE GOLDFIELDS OF BURMA.

By R. ROMANIS, D.Sc.

IT has long been known that gold occurs in the river sands of Burma. The alluvial deposits of Lower Burma have long been exhausted, but those on the Chindwin in Upper Burma are still worked to a small extent, and there is a report of platinum having been found there.

Lately I have received two specimens of gold from Mr. R. C. Stevenson, the Deputy Commissioner of Mya-daung. They were found to the westward of Katha, the head quarter station, about 30 miles from the Irrawaddi, on the banks of the Meza, in the territory of a semi-independent chief, the Wuntho Tsawbwa. The hills forming the valley of the Meza are a prolongation of those of the lower defile, which are auriferous in places. At Tigyaing, where the Meza falls into the Irrawaddi, they are composed of schistose rock. I was told that this district was famed for its diamonds, but, as I expected, they turned out to be zircon. The specimens were brought to Katha by a native, who said that one had been obtained at the foot of a range of hills, and the other in the bed of the Meza.

(A) is in comparatively large irregular fragments with quartz embedded in some of them. Under the microscope I picked out a fragment of iridosmine and a crystal of chrome iron. It also contains copper pyrites, magnetic oxide of iron, and an ore of silver, a grey mineral which lost 49 per cent on ignition.

(A).

	Gold	87·66
	Silver	5·96
Gangue	Copper pyrites	1·95
	Quartz	1·09
	Magnetic oxide of iron	0·32
	Silver	1·54
	Loss on ignition	1·48

(B) is in fine smooth grains containing little magnetic oxide. It left a residue insoluble in aqua regia, of about 17 per cent, of which about 7 per cent was iridosmine in bright flat grains mixed with a black mineral, apparently a platinum ore: the rest was zircon and quartz.

(B).

Gold	74·83
Silver	2·86
Platinum	2·53
Iridosmine	7·04
Zirconia	7·08
Silica by difference	5·66
	100·00

Mr. Mathews, now officiating civil officer at Katha, has obtained details of the methods of working. These are three:—

I. Washing with water led from the mountain streams. A channel is made across one of the little level spots found at the foot of the hills, into which the stream is diverted for a few hours, then it is turned off and the deposit formed in hollows, excavated in the bottom, is examined by washing in wooden main dishes.

II. By long ditches dug before the rains; after the floods have subsided the deposit at the bottom is examined and the gold washed out.

III. By sinking shafts to the auriferous stratum, a thin layer of dark sandy soil mixed with stones, from 7 to 30 feet below the surface, and then tunnelling laterally for a few feet; no frames or props are used in these galleries.

The out-turn does not appear to be great. In one of the five townships in which gold is obtained the annual yield is between 7 and 8 lbs., but if the Californian system of "hydraulicking" were applied where the first two methods are in use great profits might be made, if the Aborigines, Kadu Shans, did not interfere, as they are certain to do.

ON THE

SPECIFIC HEATS OF MINERALS.*

By J. JOLY, B.E.,

Assistant to the Professor of Civil Engineering, Trinity College, Dublin.

THE specific heat constant is serviceable as a means of mineral diagnosis. Its numerical value, primarily a function of the weights of the atoms present, admits of calculation to a close degree of approximation on an assumed chemical constitution, even in the case of the more complicated silicates. In a secondary degree experiment appears to show that the thermal capacity is variable with the degree of order prevailing in the molecular constitution of the mineral, tending to be a minimum in the well-crystallised substance. Thus the characteristics of roughness, opaqueness, and formlessness are accompanied with heat capacities greater than those accompanying lustre, transparency, and symmetry.

It would appear further that under one and the same crystalline form different specimens of the same mineral may exhibit quite distinct thermal capacities, not apparently accounted for directly by differences in chemical composition, but generally accompanied by difference in diaphaneity. This is shown in the cases of aquamarine and clouded beryl, sapphire and corundum, apatite, calcite, and oligoclase. This phenomenon of multiple thermal capacity is well marked also in the cases of sphalerite, pyrite, and galena, in which group of isometric sulphides there is also a numerical relation traceable between the values. The quantities, including the observations of other observers, being in continued proportion with one another. The specific heat of marcasite, the trimetric form of the disulphide of iron, enters this proportion. Thus, designating the specific heats after the initials of the minerals,

$$s_1 : s_2 :: p : m :: g_1 : g_2.$$

The phenomena observed seem to suggest the possibility of different molecular arrangements obtaining under the same crystalline form, and effecting the thermal freedom of the molecule to different extents, but in a definite way.

The specific heats, taken by the method of condensation, of a number of minerals and rocks are added in the paper.

* Abstract of a Paper read before the Royal Society, November 18th, 1886.

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 267.)

10. *Test for Lithium.*

LITHIUM is very easy to find in sulphate solutions, if we have been careful to eliminate all the gypsum as completely as possible, according to the method already explained. We precipitate the lithium as carbonate; the crystals of this salt, which are very distinct, of rectangular section, and apparently monoclinic, are about 50 to 75 microns in length.

We might be led to confound these crystals with gypsum and with the double salts formed by the combination of carbonate of magnesium with the alkaline carbonates; but the lithia salt is distinguished from the above-mentioned calcium salt by the almost constant occurrence of rectangular crystals and by its solubility in weak sulphuric acid; as for the double magnesium salts, they never form except in the presence of an excess of an alkaline carbonate, while the relative proportion of lithic sulphate and potassic carbonate has no influence on the formation of lithic carbonate.

In magnesic solutions, provided we have not added too much alkaline carbonate, we cannot see any prismatic crystals of the double salt forming, except in the immediate neighbourhood of the reagent, and these have only a momentary existence, as they almost immediately decompose and form little grains of magnesic carbonate. The presence of phosphoric acid interferes considerably with the test for lithium in the form of carbonate; in fact the addition of a solution of a phosphate leads to the destruction of the lithic carbonate already formed.

11. *Test for Barium and Strontium.*

Barium and strontium are found in the form of sulphates, in the sediment which remains in the platinum crucible, after we have decanted the aqueous solution of sulphates; this sediment still contains gypsum, when the proportion of calcium in the mineral is sufficiently great; when warmed with concentrated sulphuric acid the sediment dissolves, and, on cooling, and by the absorption of water vapour, the liquid soon throws down the barium salt in the form of little crossed lenticular crystals of about 5 to 12 microns in length.

The strontic sulphate appears later. It first forms in little confused bundles of fine needles, analogous to those we observe when gypsum separates rapidly from an acid solution; little by little we see appear crossed crystals, the smaller of which might be confounded with those formed by sulphate of barium, while the more sharply defined are easy to recognise, since they are of much larger dimensions (20 to 30 microns wide and 30 to 45 microns long), and have a rather more complicated structure. They eventually form rhombs, generally rather cloudy, and slender at the ends (they owe their formation to the matting together of the crossed crystals); sometimes these latter unite, forming twins and double twins in the form of a cross.*

The gypsum which dissolves separates later on, first as needles collected in bundles or rosettes, and finally in its ordinary form.

12. *Test for Magnesium.*

In testing for magnesium we find an ammoniacal solution of sodic phosphate a most invaluable reagent. The crystals of ammonio-magnesic phosphate have a form so sharply defined and are so characteristic by reason of their hemi-morphism, and the rudimentary crystals have such a particular structure because of this hemi-morphism, that the choice of the salt as a reagent for micro-chemical research will astonish nobody. Numerous experiments have shown me that solid ammonio-sodic hydrophosphate (a salt of phosphorus) gives the most striking results. The drop to be tested, which has already served for the alkali or aluminium tests, is supersaturated with ammonia; at a distance of about 1 c.m. we place a small drop of water, and dissolve a grain of the phosphorus salt in it; communication is then made between the two drops by means of the fine glass rod. In this experiment the distance between the two drops has a preponderating in-

* Sulphate of lead separates in the same manner from a solution of sulphuric acid in the form of crossed twins. They are of the same size as sulphate of barium (5 to 12 microns), but the shape of the crystals of strontic sulphate just described, viz., a Maltese cross.

fluence on the formation of well-defined crystals; if the solution contains 1 per cent or more of magnesium, for a considerable time after the liquids are in communication only rudimentary crystals will be formed, of about 60 microns in length at the most; these are badly defined hemimorphs. We only succeed in getting well-defined hemimorphs of about 10 to 20 microns in length in very weak solutions; these crystals, however, are a very long time in appearing if the communication between the drops is too long or too narrow. In such a case we can accelerate the action by making another streak with the glass rod at the side of the first one. If we know beforehand that the solution to be examined can only contain about 0·5 per cent at the most of magnesium, we can simplify the manipulation considerably by placing a small particle of the phosphorus salt, about 0·3 m.grm., on the edge of the drop.

Iron and manganese, which form analogous compounds to that of magnesium, can give rise to no mistakes if, after having added ammonia, we let it settle for a few minutes (the time which is necessary for the complete oxidation of ferrous and manganous salts) before commencing the operation with the ammonio-sodic phosphate.

Sometimes we cannot see the ammonio-magnesic phosphate, or we only get faint indications of it; the reason of this is that there are no ammonic salts in the solution; it is for this reason that I always recommend the addition of a little hydrochloric acid or chloride of ammonia to the liquid before supersaturating with ammonia.*

The sensitiveness of the reaction is very satisfactory; a solution containing 0·15 per cent of magnesia forms an abundance of crystals in the space of eight minutes; 0·001 m.g. of magnesia can also be found without much trouble.

13. *Test for Aluminium.*

I found it as difficult to find a reagent for aluminium as it was to find a method of indicating the presence of sodium. But in this instance my efforts have been crowned with a success more complete and still more important, inasmuch as the only blowpipe test for aluminium, that with cobaltic nitrate, permits, as a rule, of a very limited application, and loses still more of its utility when it is necessary to have recourse to the microscope. A reagent which is admirably fitted for the indication of the presence of aluminium, but which is better adapted for use with polished surfaces than with solutions, is an alcoholic solution of alizarin. We allow this liquid to react on a solution of aluminium in an alkali, and we then saturate the excess of alkali with the vapour of acetic acid. In this experiment it is much more convenient to use a strip of filter-paper than a glass plate as a support.

For the examination of prepared solutions I have found chloride of cæsium to be an excellent reagent, of which a drop is placed at the edge of the drop to be tested. It suffices to touch the surface of the liquid with the end of platinum wire carrying a small quantity of this salt, to see immediately all round the spot touched the appearance of large crystals of cæsium alum, having a diameter of about 35 to 90 microns, and showing the ordinary form; viz., the octahedra, or, more rarely, the combination of the octahedron and the cube. In solutions, no matter how weak, the formation of dendritic masses instead of isolated crystals, is preponderant; when we see them appear it is necessary to add a small quantity of water on exactly the opposite side to that where the reagent was placed. I cannot recommend dissolving the dendrites by heat, because we then obtain, on cooling, much smaller and a less number of crystals than by local precipitation at the ordinary temperature. It is also necessary to prevent a great excess of sulphuric acid. In slightly acidulated solutions the alum crystals form much quicker, and take a much better shape than in a neutral solution; and further, a slight excess of sulphuric acid favours the solution of aluminic sulphate, which is only slowly dissolved by pure water; a large excess of acid, on the contrary, interferes with and retards the formation of the alum. If any doubts cross our mind as to whether or not we have made any mistake of this kind, we can remedy it by adding an acetate such as that of sodium or of copper.

The presence of iron, even in large quantity, gives rise to no difficulty, since iron alum does not crystallise easily. In some cases, where I have thought the formation of this body possible, I have made controlling experiments with a drop of the same liquid, but in which the ferric salt has previously been reduced by zinc, without, however, arriving at discordant results.

The sensitiveness of the reaction rests on the very slight solubility of cæsium alum, of which a large part of the mass consists of water; in fact, to dissolve one part of alum we must have 200 parts of water. One hundredth of 1 m.g. is more than sufficient for a distinct reaction, provided that the solution is reasonably concentrated.

(To be continued).

* Reciprocally this reaction may serve to indicate the presence of ammonia in a solution. We add sodic phosphate and potash or soda until the reaction is alkaline; then we add a little kieserite. If ammonia is present we see, besides the flocculent precipitate of magnesia, the hemimorphic crystals above described. Nessler's solution only gives a yellow flocculent precipitate.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 269.)

Upon the conclusion of the reading of the committee's report the President called for the presentation of papers upon the subject.

In response Mr. Clifford Richardson read the following:—

On the Proper Indicator for Detection of Neutrality in Ammonium Citrate Solution for P_2O_5 Determinations.

I have been led to suspect that the cause of some of the discrepancies between analysts in the determination of citrate soluble phosphoric acid lay, at least in a minor degree, in the character of the citrate solution.

The specific gravity is, for instance, to be 1·09, but no temperature is given. Between winter and summer temperatures this might be of some importance.

Neutrality, however, is the point which I think is difficult of obtaining with certainty and uniformity by all chemists.

The question of indicators has been much discussed during the past year, and the principal references I have collected as an appendix to this paper.

The results obtained by the investigators referred to have led me to examine especially the relation of various indicators to citric acid and ammonia.

Solutions were prepared of standard strength, fifth normal, of citric acid and ammonia, and observations made of how closely the various reagents indicated neutrality.

The results, together with a comparison of the use of soda in place of ammonia, and oxalic acid in place of citric, are presented in the accompanying table. (See next page).

With coralline in a saturated alcoholic solution, five drops used in titration gave a sharp change from yellow to pink.

With citric acid and ammonia the indication was less marked than with soda, but easily distinguished.

Thomsen says he found rosolic acid, the colouring matter of coralline, incompatible with ammonia and citric acid. This is not entirely true, and coralline may be depended on for such indications as it furnishes with enough distinctness to read.

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

Experiments with Indicators.

Acid, N/5.	C.c. taken.	Alkali, N/5.	C.c. taken.	Indicator.	Remarks.
Oxalic	10·0	Soda	10·05	Coralline	Sharp.
	10·0	,, ...	10·05	,,	,,
	10·0	Ammonia	10·0	,,	,,
	10·0	,, ...	9·9	,,	,,
Citric	10·0	Soda	10·1	,,	Not as sharp.
	10·0	,, ...	10·0+	,,	,,
	10·0	Ammonia	10·0	,,	Less sharp.
	10·0	,, ...	9·9	,,	,,
Oxalic	10·0	Soda	10·05	Lacmoid	End not sharp.
	10·0	,, ...	10·1	,,	,,
	10·0	Ammonia	9·95	,,	,,
	10·0	,, ...	9·9	,,	,,
Citric	10·0	Soda	9·9	,,	Indistinct.
	10·0	,, ...	10·3	,,	,,
	10·0	Ammonia	10·0?	,,	Uncertain.
	10·0	,, ...	—	,,	,,
Oxalic	10·0	Soda	10·7	Poirrier's blue	Not sharp.
	10·0	,, ...	10·8	,,	Indistinct.
	10·0	Ammonia	12·3	,,	,,
	10·0	,, ...	(?)	,,	,,
Citric	10·0	Soda	10·7	,,	Not sharp.
	10·0	,, ...	10·7	,,	,,
	10·0	Ammonia	11·8	,,	Indistinct.
	10·0	,, ...	14·0	,,	,,
Oxalic	10·0	Soda	10·5	Methyl orange	Sharp.
	10·0	,, ...	10·6	,,	,,
	10·0	Ammonia	—	,,	Not changed.
	10·0	,, ...	—	,,	,,
Citric	10·0	Soda	10·6	,,	Sharp.
	10·0	Ammonia	—	,,	Not changed.
Oxalic	10·0	Soda	9·6	Cochineal	Sharp.
	10·0	Ammonia	9·6	,,	Less sharp, but distinct.
Citric	10·0	Soda	7·0	,,	,,
	10·0	Ammonia	6·3	,,	,,
Oxalic	20·0	Soda	10·1	Phenolphtalein	Sharp.
	10·0	Ammonia	10·1	,,	Not so sharp.
Citric	10·0	Soda	10·3	,,	Sharp.
	10·0	Ammonia	10·6	,,	Not sharp.
Oxalic	10·0	Soda	20·0	Litmus paper	Sharp but changes.
	10·0	,, ...	10·05	,,	Reddens on drying.
	10·0	Ammonia	10·0	,,	Paper in liquid.
	10·0	,, ...	10·2	,,	Drop method.
Citric	10·0	Soda	10·3	,,	,,
	10·0	,, ...	10·0	,,	Paper in liquid.
	10·0	Ammonia	10·0	,,	,,
	10·0	,, ...	10·3	,,	Drop method.
Oxalic	10·0	Soda	10·0	,,	Paper in liquid.

With lacmoid the change from red-brown in acid solution is gradual to a violet tint, but is easily followed to a standard colour, except with ammonia, where the change is too gradual.

Poirrier's blue C 4 B in a similar way is easily followed, except with ammonia, from blue to a reddish tinge.

Methyl orange, as described by others, could not, apparently, be obtained in this country. That used was marked Poirrier's Orange No. 3, and was from four sources. It was turned from yellow to red-brown by soda, giving a distinct indication, but was not affected by ammonia. The point indicated with oxalic and citric acids and soda was not, however, neutrality.

Cochineal, in experienced hands, is a fine indicator, but requires a practised eye, and is of no value with organic acids and ammonia for determinations of absolute neutrality.

Phenolphthalein is excluded from consideration by its behaviour with ammonia.

Litmus-paper, as usually prepared, is not reliable. When made by the directions of Sutton* it is very sensitive, and when immersed in the liquid to be tested gives valuable indication. If a drop of citrate of ammonia is allowed to evaporate on the paper it is reddened, however, so that this method of testing cannot be employed.

Several other indicators have been mentioned frequently of late, such as phenacetolin and gallein. These it was not in my power to investigate.

From the results I was led to conclude that coralline and litmus-paper, carefully prepared by the method given by Sutton and immersed in the citrate solution, are the only indicators available for determining neutrality of citrate of ammonia, with a decided preference for coralline. Litmus is not as delicate, and when used by the drop method in the air is quite unreliable.

I would recommend that coralline be prescribed by the Committee as the required indicator, and that the specific gravity of the citrate be determined at 2 ° C.

* Francis Sutton, "Systematic Handbook of Volumetric Analysis," Fourth Edition. London: Churchill, 1882, pp. 30-31.

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(To be continued).

Journal chem. Soc. Lviii. 196.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

November 27th, 1886.

Prof. W. G. ADAMS in the chair.

THE following papers were read:—

"*On a Method of Measuring the Coefficient of Mutual Induction of Two Coils.*" By Prof. G. CAREY FOSTER, F.R.S.

The two coils are, for convenience, designated by P and S (primary and secondary). The method, as originally devised, consists of two parts:—(1). Observing the swing of the needle of a galvanometer placed in γ, is started in the primary. (2). Placing the galvanometer and a condenser of known capacity, C, as a shunt between the two points A and B of the primary circuit, such that the first swing of the galvanometer needle, on completing the primary, is the same as in (1). It is easily seen that under these conditions $M = C r r_1$, where M is the coefficient to be determined; r = resistance between the points A and B; and r_1 = resistance of galvanometer and secondary coil. The method requires the value of γ to be the same in the two experiments, and facilities for varying r without altering γ. To overcome these difficulties the arrangement has been modified so as to make it a null method. The connections remain the same as in (2), excepting that the ends of the secondary coil are connected to the terminals of the galvanometer through a variable resistance with no self induction. If p be the resistance of the secondary coil, and variable resistance when adjusted so that on completing the primary circuit the integral current through the galvanometer is zero, it is shown that $M = C p r$ where C and r have the same meaning as before. For let A and E be the potentials of the galvanometer terminals at any time t, q the resistance of galvanometer, y the current through it, and N and L the coefficients of self induction of the galvanometer and secondary coil respectively. Then, considering the path from A to E through the secondary coil, we have—

$$A - E = p\,x + L\frac{dx}{dt} - M\frac{dy}{dt}.$$

For path through galvanometer—

$$A - E = q\,y + N\frac{dy}{dt}.$$

Equating these, and integrating from $t=0$ to $t=\infty$, we get

$$p\int_0^\infty x\,dt - M\gamma - 0.$$

Since $\int_0^\infty x\,dt$ = charge of condenser,

$$= C\gamma r,$$

we see that $M = C p r$.

It is easily shown that if $L = M$, then $A - E = 0$ for all values of t. Hence the galvanometer might in this case be replaced by a telephone.

By inversion the method could be used for determining the capacity of condensers in absolute measure if M be known. The author thinks the method will be useful for dynamo machines, and gave a series of numbers obtained by experiments on different coils, showing that it gives consistent results.

Mr. C. V. BOYS suggested that by arranging a switch to change the connections from (1) to (2) in rapid succession a steady deflection might be obtained, and thought that this would enable very small coefficients to be determined.

Remarks by Prof. FORBES, Prof. ADAMS, and Prof. PERRY were answered by Prof. FOSTER and Dr. FISON.

"*On the Critical Mean Curvature of Liquid Surfaces of Revolution.*" By Prof. A. W. RÜCKER, M.A., F.R.S.

The paper is chiefly mathematical, and deals with liquid surfaces of revolution attached to two circular rings, the planes of which are at right angles to the line joining their centres. By "mean curvature" the author designates *half the sum of the reciprocals of the two principal radii of curvature of the surfaces.*

Maxwell has shown, in his article on Capillary Action ("Enc. Britt."), that if the film be a cylinder a slight bulge will cause an increase or decrease in the mean curvature, according as the length is $<$ or $>$ $\frac{\pi}{2}$ times the diameter. If—

$$l = \frac{\pi}{2}d$$

then a small change in the volume of the surface will modify its form, but will not alter the mean curvature. Thus the mean curvature of such a cylinder is evidently a maximum or minimum with respect to that of other surfaces of constant mean curvature, which pass through the same two rings at the same distance apart, and which differ but little from the cylindrical form. Hence the cylinder may be said to have a *critical mean curvature* when the distance between the rings is $\frac{\pi}{2}$ times their diameter. If the distance between the rings is altered a similar property is possessed by some other surface. The author's paper investigates the general relation between the magnitude and distance apart of the rings, and the form of the surfaces of critical curvature.

If x is the axis of revolution, then the equation to a liquid surface of revolution is given by the expressions $x=\alpha E+\beta F$, $y^2=\alpha^2\cos^2\phi+\beta^2\sin^2\phi$, where F and E are elliptic integrals of the first and second kinds respectively, of which the amplitude is ϕ and the modulus—

$$K=\sqrt{\alpha^2-\beta^2}/\alpha.$$

As usual—

$$\Delta=\sqrt{1-K^2\sin^2\phi},$$

whence $y=\alpha\Delta$; and if $K=\sin\theta$, then $\beta=\alpha\cos\theta$; and since $\alpha>\beta$, α and β are the maximum and minimum ordinates.

The results show that as θ increases from 0° to 90° the surface of critical mean curvature is an unduloid, with limits of cylinder and sphere, when $\theta=0°$ and $\theta=90°$ respectively. When θ passes from 90° to 180° the surface is a nodoid, with limits of sphere and a circle whose plane is perpendicular to the surface of revolution. In the third quadrant the surface is still a nodoid, the limits of which are a circle and the catenoid. Finally, in the fourth quadrant the surface is an unduloid, the limits being the catenoid and cylinder. Experiments were shown proving that with cylindrical films where $l<\frac{\pi}{2}d$, increase of internal pressure produced a bulging, whereas if $l>\frac{\pi}{2}d$ a bulging was produced by decrease of pressure. From this it is evident that if the interiors of two cylindrical films whose $l<\frac{\pi}{2}d$ be connected, stable equilibrium will result, whereas if $l>\frac{\pi}{2}d$ there will be unstable equilibrium. These facts were illustrated experimentally with great success.

After some remarks by Mr. C. V. Boys the proceedings terminated.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

Friday, November 26th, 1886.

Mr. J. J. Coleman, F.I.C., F.C.S., President, in the chair.

Mr. G. G. Henderson, M.A., B.Sc., was elected Vice-President and Mr. John Tatlock Secretary.

It was announced that the "Graham Gold Medal" would be awarded at the end of 1887 for the best paper upon pure or applied chemistry communicated and read to the Society during the three sessions ending April, 1887, and that papers would still be received, but should be sent early so as to receive proper consideration. The authors of papers need not necessarily be members of the Society.

Neutralisation-Heat of Homologous or Isomeric Monobasic Acids.—H. Gal and E. Werner have determined these heats for the isobutyric, trimethylacetic, caproic, and isobutylacetic acids.—*Comptes Rendus.*

NOTICES OF BOOKS.

Commercial Organic Analysis. A Treatise on the Properties, Modes of Assaying, and Proximate Analytical Examination of the Various Organic Chemicals and Products employed in the Arts, Manufactures, Medicine, &c., with Concise Methods for the Detection and Determination of their Impurities, Adulterations, and Products of Decomposition. Vol. II.—Fixed Oils and Fats, Hydrocarbons, and Phenols. By A. H. Allen, F.I.C., F.C.S., &c. Second Edition, revised and enlarged. London: J. and A. Churchill.

This volume has long been looked for, and now it has appeared it will, we think, be received with very general satisfaction. The author, as all readers of the foregoing volume and of the former edition will be aware, has proceeded on a system the direct reverse of that adopted, *e.g.*, in Dr. Normandy's "Commercial Handbook of Chemical Analysis." He does not give in alphabetical or other order the various organic articles of commerce, the intermediate products, raw materials, and residues, but he gives what may be called a systematic classification of organic products, giving of course prominence to those which are chiefly used in the arts. Thus the three main divisions of this volume are—Fixed Oils and Fats, Hydrocarbons, and Phenols.

The aromatic acids and tannin, also the colouring-matters, cyanogen compounds, organic bases, albumenoids, &c., are announced as to follow in the third volume. It is not easy to pronounce whether, of the two arrangements, that of Mr. Allen or that of Normandy and others should be preferred.

For the determination of the fatty matters in milk the author gives a process, devised by Mr. A. Adams, and formally recommended by a Committee of the Society of Public Analysts. For the details of this method we must refer to the work itself.

The examination of oils is discussed at considerable length, the physical properties and chemical reactions by which they are distinguished being described in a very elaborate manner. There are Tables of the specific gravities of oils, taken both at 15·5° and at 98°—99°, as recommended by Estcourt. At the latter temperature the observation is preferably made with a Sprengel tube, or, if the quantity of the sample is sufficient, with a Westphal balance. A further Table gives a very comprehensive classification of the oils, with their respective classification equivalents. The author thinks it probable that linoleic acid has a higher molecular weight than that commonly assigned to it.

Considerable attention has been paid to the recognition of the presence of hydrocarbons in fixed oils, an addition which is now frequently made both for legitimate and for fraudulent purposes.

Under "Cotton-seed Oil" he remarks that its principal applications are in soap-making and in the manufacture of factitious butter. For this purpose we should consider it decidedly preferable to any animal fat, as there is no possibility of the introduction of disease-germs.

The process described in a footnote, as followed in the preparation of cod-liver oil, is scarcely on a level with the practice of the present day.

The two kinds of Turkey-red oils—the old emulsive oil, or *huile tournante*, and the more recently discovered "alizarine oil" obtained from castor oil—are clearly distinguished, and satisfactory methods for their examination are laid down. This is a point of some value, since these two oils are occasionally confounded, and since alizarine oils occur in the market which are of very inferior value.

The statement of Wanklyn and Fox, that manufacturers never obtain more than 5 per cent of glycerin on saponifying fats, is shown to be at issue with experience, as some manufacturers actually recover from 7½ to 8 per cent, although a not inconsiderable quantity is lost during

by the same chemists, is pronounced to be ingenious but unsupported by evidence.

The account of the behaviour of soaps, of the additions to which they are liable, and of the methods to be followed in their examination, is thorough-going, and will be found most useful. We find the remark that saponification in the so-called cold process is very incomplete. This is perfectly true in the case of soda-soaps, which the author has in view, but with potash the result is much more satisfactory. The addition of cane-sugar to soaps is justly condemned as a mere dilution. The value of glycerin, over and above the proportion formed during saponification, is duly recognised. We note as a curiosity that a certain advertised soap, the alleged curative properties of which are ascribed to an admixture of milk and sulphur, contains neither of these bodies, but instead "a large admixture of china clay and a most objectionable proportion of free alkali."

There is an outline general scheme for the analysis of soaps, which of course every analyst will somewhat modify according to circumstances.

It is recommended that manufacturers' soaps should be tested for the proportions of water, total alkali, and crude fatty acids; while the percentages of caustic alkali, alkali as carbonate and silicate, combined fatty and resin acids, and free fatty acids and unsaponified oil, are secondary determinations which are frequently of considerable importance.

The second chapter of the volume is devoted to the hydrocarbons, and passes in review a truly vast number of products, some of them of extreme importance. Separate sections treat of the tabular arrangement of hydrocarbons in series; destructive distillation and its products; the tars, bitumens, petroleums, and shale-products; the terpenes and their allies; benzene and its homologues; naphthalene and its derivatives; and, lastly, the anthracene group. Mr. Allen draws here a very useful distinction between benzene, the definite chemical individual, and benzol, the commercial mixture of benzene with some of the homologues and with certain impurities. We recommend this distinction for general adoption, since there prevails at present a most annoying confusion between benzene, benzol, benzine, and benzoline, terms sometimes used as synonyms and sometimes applied to distinct bodies. A similarly useful distinction is here drawn between nitrobenzene and nitrobenzol, toluene or toluol, &c.

The last chapter, which space does not allow us to examine, deals with the phenols.

This volume, like its predecessor, will doubtless be very generally appreciated by chemists. The index might with advantage have been more copious.

The Swelling Power of the Sulphocyanides, and Tumefaction as the Cause of Fermentative Reactions. (Die Quellkraft der Rhodanate, und die Quellung als Ursache fermentartiger Reaktionen.) By Dr. Eduard Meusel. Gera: A. Reisewitz.

The author of this work entered upon his investigations with a view to ascertain the reason why sulphocyanides exert a destructive action upon vegetation. Comparative experiments made upon peas, beans, grains of wheat, rape-seed, and linseed, with ordinary water and with solutions of the sulphocyanides, showed that no germination took place in presence of the latter, even in such small quantities as ½ per cent. The seeds moistened with these solutions swell up more quickly and rapidly than those soaked with pure water. Further, whilst in the latter case the cotyledons remain almost dull, those in contact with a sulphocyanide solution became almost transparent at the margin and decidedly translucent even in the middle. The sulphocyanide solutions appeared to have exerted a solvent power, withdrawing from the seeds gluten, and albumenoids in the other seeds. The injurious action of sulphocyanides upon vegetation is due especially to their specific power of producing abnormal swelling.

Solutions of sulphocyanides, at from 15 to 20 per cent, convert starch at once into paste at ordinary temperatures. The presence of other salts retards this action, with the exception of common salt and of calcium chloride. A 30 per cent of this latter salt alone converts starch gradually into paste at the common temperature. Stronger solutions do not effect this reaction.

As regards the action of the sulphocyanides upon vegetable albumenoids, the author has observed that the albumen of the carrot and the legumine of beans are both coagulated by the sulphocyanides in the shape of fine flocks. The gluten of cereals swells up strongly, and dissolves in liquids containing sulphocyanides and is re-precipitated by phosphoric acid.

The effects of sulphocyanides upon egg-albumen may be shown as follows:—8 parts of potassium sulphocyanide are rapidly dissolved in 30 parts white of egg, and filtered. In about two days the filtrate congeals, at common temperatures, to a white gelatinous mass, from which water extracts no soluble albumen. If the white of egg is first acidified with phosphoric acid, an addition of sulphocyanide produces at once a white precipitate of coagulated albumen.

The serum of blood, mixed with 5, 10, or 15 per cent of ammonium sulphocyanide, has a very slight acid reaction, and if left to itself, at ordinary temperatures, for a day it becomes a transparent jelly, which on treatment with water yields white insoluble albumen, whilst the filtrate still holds albumen in solution. If serum is very faintly acidulated with hydrochloric acid, and a very small quantity of a sulphocyanide is further added, it coagulates about the temperature of the blood, a circumstance which may be pathologically important.

Hides previously freed from hair and immersed in solutions of a sulphocyanide, swell up to nearly five times their former thickness, and become remarkably elastic. If the solution is weak, the hide on drying will lose this elasticity, but if it contains from 20 to 24 per cent of the solid salt the mass on drying becomes perfectly equal to caoutchouc in elasticity. Animal membranes which have been swelled by soaking in a sulphocyanide allow animal albumen, which is otherwise of a colloidal nature, to diffuse through them. The author is of opinion that the presence of albumen in urine is proof of an abnormal swelling of the membranes or membranous tissues

For the detection of albumen in cases where the necessary reactions of nitric acid might prove objectionable, the author recommends to acidify strongly with phosphoric acid, and then to precipitate the albumen with ammonium or potassium sulphocyanide.

The sulphocyanogen present in the saliva he considers as having the function of keeping the mucous membranes moist and elastic, and of aiding in the saccharification of starch.

In an especial section, in which there occurs no mention of the sulphocyanides, Dr. Meusel explains the intense and rapid action of the nitrates as top-dressings by their power of accelerating saccharification. On the contrary, carbolic and salicylic acids check the saccharification of starch.

In a final section the author infers that almost every substance is capable of saccharifying starch in proportion to its power of enveloping water.

Manual of Assaying Gold, Silver, Copper, and Lead Ores. By Walter Lee Brown, B.Sc. Second Edition, thoroughly revised, corrected, and augmented. Chicago: Sargent and Co.

In the Preface the author expresses his conviction that there is no book in the language on the subject occupying

the place which his work seeks to fill. Some such publications he considers antiquated, whilst others fail to supply the necessary details or are more suitable as works of reference. Omission of complete working instructions is a fault which certainly cannot be laid to Mr. Brown's charge; he describes every appliance and every process in a very clear, thorough-going, painstaking style.

In the introduction we find a praiseworthy attempt to draw a clear distinction between *assaying* and *analysis*. The former art he defines as the method of finding out "of what a substance is composed, and the proportions by means of *dry* reagents and *heat*," whilst analysis reaches the same end by the use of *wet* reagents with or without heat. Mr. Brown is of course aware that his distinction, though very convenient, is not the only one which has been proposed. Thus some writers insist that the task of the analyst is the detection and determination of every substance present in a compound or mixture, whilst the assayer seeks merely to determine some one constituent upon which the commercial value of the sample chiefly depends; whilst others, again, call every determination effected for the purposes of manufacture or trade an assay.

In the first part of the work the author describes the apparatus and reagents required by the assayer. He sets out with the appliances for comminution, figuring and describing the crushing-mills of Lipsy, Krom, and Bosworth, which, when the work to be done is abundant or the samples bulky, should be driven by power. The Richards pulveriser, or "arrestra," is recommended for the amalgamation of small quantities of ores.

The subject of scales and balances is introduced at some length, and the instructions for manipulating these delicate appliances are satisfactory. Among balances the palm is awarded to one of Oertling, though that by Ainsworth is pronounced "a recent but worthy rival to the Oertling." It is said to be sensitive to 1-100th milligramme.

Among furnaces the first place is given to those employing gaseous fuel, where such is to be had. Some of those figured and recommended, such as the "Monitor," are modifications or adaptations of Fletcher furnaces.

Hoskins's "hydrocarbon assay-furnace," burning refined petroleum or gasoline, receives also a very good character.

Under the head "Reagents" we notice a useful Table of the reducing power of different forms of carbons, carbohydrates, &c.

The careful testing of reagents before putting them in actual use is insisted on. The author, while giving a suitable method for determining silver and lead, points out that litharge absolutely free from silver cannot be met, and that if it could the advantage would be very doubtful.

In Part II. the author formally describes the most approved process for assaying ores of gold, silver, copper, and lead. He mentions that the colours shown by the interiors of scorifiers are often characteristic of the ores tested, and in conjunction with the colours of the cupels like valuable test. The colours thus produced in the respective presence of copper, iron, lead, manganese, chrome, and uranium, are shown in a coloured plate.

The chapter on the dry assays of copper ores is brief, the author fully recognising their want of accuracy.

The Appendix contains, among other valuable matter, description of Luckow's electrolytic analysis of copper ores; of the volumetric method for the same ores with potassium cyanide in an ammoniacal solution, instructions being given for eliminating interfering metals, such as zinc, nickel, and cobalt; the pan-test for gold; the parting assay of gold ores; qualitative tests for acids, and for the acids accompanying them in ores; determination of sulphur in pyrites, for which he recommends treatment with potassium chlorate and nitric acid.

The Appendix further contains lists of the minerals occurring in the United States known to contain gold, silver, copper, or lead; a catalogue of books on subjects more or less connected with assaying; a plan showing the arrangement of an assay laboratory; together with a variety of Tables. The Index is fairly copious.

The work is, of course, mainly drawn up with an eye to American affairs, but we believe that it will be found useful in all countries where the English language is spoken.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 20, November 15, 1886.

Researches on the Phosphates.—M. Berthelot.—The insoluble alkaline-earthy phosphates obtained by double decomposition with tribasic sodium phosphate are capable of several distinct conditions, the one colloidal, gelatinous, containing a large proportion of water retained by the salt, properly so-called; the other crystalline, containing also combined water, but in a smaller proportion. The formation of the colloidal salt is accompanied by an absorption of heat, followed by a very considerable disengagement, which answers at once to the crystallisation and to the changes which take place in the state of combination of the acid with the base, and of the resulting salt with water.

Velocity of Dissociation.—H. Lescœur.—The considerations drawn from the velocity of dissociation yield valuable information as to the existence of hydrates and analogous compounds; but they can throw no light, either absolutely or relatively, on the value of the tensions of dissociation. The velocity of dissociation, in fact, is not merely a function of the tension of dissociation, but it depends also on the physical condition of the bodies, an element which eludes all measurement.

Certain Laws of Chemical Combination.—MM. de Landero and R. Prieto.—The authors consider chemical combination as being produced by a shock between the particles of the element forming a compound. They suppose that the particles of each element are in motion with a certain speed, and that such speed is a constant characteristic of each body. The loss of energy or of *vis viva* due to the shock between the non-elastic particles is considered as the equivalent of the quantity of heat liberated by the combination.

Journal für Praktische Chemie.
New Series, Vol. xxxiv., Parts 6 and 7.

Picolic and Nicotinic Acid.—Eugen Seyfferth.—The author describes the behaviour of picolic acid with fuming hydriodic acid, with zinc powder and glacial acetic acid, and with phosphorus pentachloride. He then discusses the reactions of nicotinic acid with phosphorus pentachloride.

On the Transferrers of the Halogens.—C. Willgerodt.—There are addition- and substitution-transferrers. Among the former are aluminium hydroxide and alum. They must, above all things, possess the property of not effecting the substitution of hydrogen by the halogens, since addition disappears where substitution occurs. It seems to the author that no substance can be at once an additive and a substitutive transferrer. The additive transfer of the bodies mentioned seems to depend not upon chemical, but upon purely mechanical processes, and is mediated by their relation to light. No elements capable

haloid are substitutive transferrers. Some, though not all, elements which form tri-, tetra-, or penta-haloids, are transferrers, the efficacy of a body in this respect depending not merely on its grade of halogenation, but upon the movability of the halogen atoms in the compound. This latter property again is, in part at least, a function of the chemical affinity of the inorganic haloid and of the organic substance. If the transferring elements are arranged according to the natural groups of the periodic system we find that the haloids of the elements of the first group are not transferrers. Gold is an exception; this element belongs to the natural group of aluminium and thallium. If we leave it in the first group we see that this mono- and trivalent element has the highest atomic weight in the group, and we are thus led to the idea that the transferring power of an element of a group is connected with the atomic weight. The elements of the second group are not transferrers. In the third group boron, with the lowest atomic weight, seems not to transfer; thallium, the final element of this group, is a brilliant transferrer. In the fourth group carbon and silicon are doubtful; tin is very efficient; lead does not transfer, as $PbCl_4$ is not formed under the circumstances. In the fifth group nitrogen, phosphorus, and arsenic have no action; antimony is very powerful; bismuth less so, since, though its atomic weight is higher, it forms only a tri-compound, in which the halogen is less movable than in the corresponding penta-compound. In the sixth group sulphur is the first transferrive element, tellurium is much more energetic, as is also molybdenum. In the seventh group iodine is a powerful transferring agent, and in the eighth, iron.

Weight of Drops, their Relation to the Constants of Capillarity, and the Capillary Marginal Angle.—J. Traube.—In this interesting investigation, the completion of which has yet to follow, the author proposes the following law:—"The volumes of drops are proportional to the height at which the liquids stand in capillary tubes, or, the weights of the drops are proportional to the products of the capillary ascent into the specific gravity.

Calorimetric Researches.—F. Stohmann.—In his ninth and tenth memoirs, here included, the author discusses the thermic value of the homologues of phenol, and the thermic value of the methyl groups in homologous phenols.

Ultramarine Blue in the Moist Way.—F. Knapp.—The author describes the production of ultramarine blue in the moist way from a variety of mixtures in which all the constituents of ordinary ultramarine are not present. Common salt may be permanently tinged blue with sulphur alone.

Production of Substituted Stilbenes from Substituted Halogen Benzyles.—K. Ebs.—The author obtains a para-brom-benzoic ethylester, a colourless mobile liquid, heavier than water, soluble in the ordinary solvents except water, boiling at 236° under the pressure of 713 m.m., and being saponifiable only with great difficulty.

On Substituted Stilbenes.—K. Ebs and F. Bauer.—In this first communication the authors treat of para-dinitro-stilbene.

The Derivatives of Taurine.—J. W. James.—Here the author describes the decomposition of trimethyl-taurine with bases, and its behaviour with cyanamide and hydriodic acid.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 4th Série. Vol. i., No. 8, August, 1886.

The Solubility of Antimony Oxide in an Alkaline Solution of Glycerin. A New Mordant for Cotton-Dyeing.—Dr. H. Kohler.—The author proposes to dissolve antimony oxide in an alkaline solution of glycerin and to use the resulting liquid in cotton-dyeing, especially for fixing tannin upon the fibre.

Chemical Scholarship.—We wish to draw the attention of our younger readers to a Scholarship of the value of £50 per annum, tenable for two years, which will be awarded at University College, Liverpool, to Chemical Students, early in December. The Scholarship, which bears the well-known name of Sheridan Muspratt, is not confined to Students of the College. Further particulars will be found in our Advertising Columns.

On Certain Derivatives of Methyl Carbanilate.—W. Hentschel.—By cautiously heating methyl carbanilate with sulphuric acid there is formed a soluble compound which the author at first regarded as sulpho-methyl-amido benzoic acid, but which may, perhaps, be rather regarded as the sulphonic acid and methyl carbanilate.—*Journ. fur Prakt. Chemie.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Official Chemists.—1. How many chemists are employed at Somerset House, and where and how can I get information as to the payment they receive and the manner of their appointment? 2. Are there any appointments open to chemists under the Board of Trade, the Board of Works, the Home Office, Local Government Board, War Office, Admiralty, and Customs? 3. Where can I find information relating to them?—A. B. H. FAUDELLE.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Principle and Practice of Ornamental Design," by Lewis Foreman Day.
—— Society of Chemical Industry, 8. "On Strontium Hydrate," by E. H. Traschel.
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 7th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 8th—Society of Arts, 8. "Glow Lamps, their Use and Manufacture," by Major-Gen. C. E. Webber.
—— Pharmaceutical, 8.
THURSDAY, 9th.—Royal, 4.30.
—— London Institution, 6.
—— Royal Society Club, 63.0.
—— Mathematical, 8.
FRIDAY, 10th.—Astronomical, 8.
—— Quekett Club, 8.
SATURDAY, 11th.—Physical, 3. "On the Influence of Change of Condition from the Liquid to the Solid State on Vapour Pressure" and "On the Nature of Liquids as shown by a Study of the Thermal Properties of Stable and Dissociable Bodies," by Prof. W. Ramsay and Dr. Sydney Young. "On Caudry's Theory of Reflection and Refraction," James Walker.

UNIVERSITY COLLEGE, LIVERPOOL.

SHERIDAN MUSPRATT CHEMICAL SCHOLARSHIP.
Of the value of £50 per annum, tenable for Two Years.

The Examination for this Scholarship will commence on December 9th, the subjects of examination being:—
The Principles of Chemistry.
Chemistry of the Metals and Non-Metals.
Elements of Organic Chemistry.
Qualitative Analysis and General Laboratory Work.
Simple Quantitative Analysis.

The examination in these subjects will extend over three days, one at least of which will be devoted to practical work in the Laboratory. Candidates who have not taken a University Degree will further be required to satisfy the Examiners in—
1. Physics: especially Heat and Electricity.
2. Mathematics; especially Algebra up to Binomial Theorem and Logarithms.

The Examination is open to all, but preference will be given to Candidates under 23 years of age, provided that they come up to the requisite standard.

Candidates should send their names on or before Dec. 6th to
THE REGISTRAR.

THE CHEMICAL NEWS.

Vol. LIV. No. 1411.

PENTASULPHIDE OF ARSENIC.

(Preliminary Notice).

By LEROY W. McCAY, D.Sc.

A solution of an alkali arseniate strongly acidified with hydrochloric acid and saturated with sulphuretted hydrogen gas is, when heated for *one* hour in a tightly stoppered bottle and in a water-bath, the water of which has been brought to active boiling, completely changed to pentasulphide of arsenic—

$$2H_3AsO_4 + 5H_2S = As_2S_5 + S(H_2O).$$

The lemon-yellow precipitate is free from any admixture of As_2S_3. It is chemically pure As_2S_5, barring the presence of a trifling quantity of sulphur, which is separated from the excess of sulphuretted hydrogen by the action of the air dissolved in the liquid or left in the upper part of the bottle. By boiling the solution prior to passing the sulphuretted hydrogen gas, filling the bottle almost full of freshly boiled water, and then heating for one hour in the boiling water-bath, the amount of sulphur precipitated sinks practically to a vanishing quantity, and the sulphide is obtained in a state which, as said, is to all intents and purposes chemically pure. The pentasulphide thus obtained exhibits the following reactions: (1) Carbon bisulphide extracts from it no sulphur; (2) it is soluble in strong ammonia water without the separation of sulphur; and (3) the ammoniacal solution, when diluted, shaken up with excess of nitrate of silver, and filtered, gives a clear filtrate, from which, upon the careful addition of nitric acid, reddish brown arseniate of silver is precipitated.

This method of precipitating arsenic as the pentasulphide is extremely interesting, and serves to substantiate the results arrived at by Bunsen, who, in 1878, showed that As_2S_5 was indeed formed by the action of sulphuretted hydrogen gas upon arsenic compounds in solution, but only completely thrown down provided the solution of arsenic acid be kept hot, and the gas in large quantities be passed for a very long time.

I have spent much time and labour in endeavouring to clear away the uncertainty which attaches to this subject of the formation of pentasulphide of arsenic by the action of sulphuretted hydrogen upon arsenic acid, and I trust ere long to be able to publish a detailed account of my work. Experiments, test analyses, and so on, I withhold, then, for some time in the near future.

John C. Green School of Science, Princeton, N.J.,
Nov. 10, 1886.

A NEW AND SIMPLE METHOD FOR ESTIMATING FLUORINE, ESPECIALLY APPLICABLE TO COMMERCIAL PHOSPHATES.*

By A. CHAPMAN.

This method depends on the fact that acid ammonic acetate (*i.e.*, ammonia more than neutralised by acetic acid) precipitates calcic fluoride, but not calcic phosphate, from solution in acids.

2·5 grms. are ignited in a platinum crucible for a short time (this ignition prevents ferric and aluminic phosphates from dissolving in dilute hydrochloric acid), transferred to a mortar, and ground up with repeated small quantities of 10 per cent hydrochloric acid, filtered, and washed.

The filtrate and washings are made up to 250 c.c. 100 c.c. of this are taken and added to the acid ammonic acetate, the calcic fluoride is precipitated, and calcic phosphate remains in solution.

The calcic fluoride is filtered off, washed, dried, ignited, and weighed as usual.

If the substance be not ignited the calcic fluoride comes down mixed with ferric and aluminic phosphates, from which the amount of calic fluoride can be obtained by subtracting the amount of ferric and aluminic phosphates.

This second method is not so accurate, as, even without ignition, all the ferric and aluminic phosphates do not dissolve up.

This method was originally devised by Dr. Graham, of the Birkbeck Laboratory, University College.

* Read before the Chemical and Physical Society, University College, Dec. 2, 1886.

THE UNITED STATES LABORATORY AT THE NEW YORK PUBLIC STORES.

By MARCUS BENJAMIN, Ph.B., F.C.S.

In the Chemical News, vol. liii., p. 267, was published a historical sketch of the United States Laboratory, together with an account of the library and two of the three branches of the laboratory department. The remaining branch, a description of which will complete the subject, is under the immediate charge of Jesse P. Battershall, who studied in the Columbia College School of Mines, and subsequently received the degree of Doctor of Natural Philosophy, at the University of Tübingen, Germany, for original investigations in the naphthaline series. Dr. Battershall is assisted by Mr. J. Howard Wainwright, Ph.B., F.C.S., a graduate of the Columbia College School of Mines; Dr. J. Frank Davis, who was graduated at the Bellevue Hospital Medical College; and Mr. Ernest G. Chapman. The laboratory, which is a moderately well equipped one, is the only establishment of its character connected with the United States Customs Service. It contains several scales, including two of Becker's most delicate balances, on which it is possible to weigh one one-hundredth of a milligramme; an excellent assortment of platinum-ware, of which the large evaporating dishes are used in the determinations of ash in the tea assays; a Scheibler's carbonic acid apparatus; well arranged water baths for evaporation, where at times upward of a dozen determinations of morphine are being carried on; blast apparatus; Fletcher's burners; combustion furnaces for organic analysis, and other conveniences too numerous to mention.

The character of the work is, naturally, somewhat varied; it includes assays of tea; of drugs, such as opium, quinine, jalap, and similar substances; analysis of lead, ashes, various alloys, iron and copper ores; determinations of alcohol in wines, spirits, tinctures, and other preparations of drugs; also examinations of glycerin, kainit, and many other qualitative and quantitative estimations for customs purposes.

The unsatisfactory nature of the teas brought into the United States led to the passing of an Act by Congress prohibiting the importation of "any merchandise for sale as tea, adulterated with spurious or exhausted leaves, or which contain so great an admixture of chemicals or other deleterious substances, as to make it unfit for use." In consequence of this Act all teas are now analysed at the U.S. laboratory. Those samples which fail to comply with the requirements cannot be entered in this country, and they are re-shipped and sold elsewhere. During the year 1883 upward of seven hundred examinations of tea were made, and this number has steadily increased since.

The tea assays, which are chiefly made by Dr. Davis, consist of the following determinations:—Total ash, ash

insoluble in water, ash soluble in water, ash insoluble in acids, extract, insoluble leaf. The method of analysis followed is the one devised by Dr. Battershall, and described by him in his "Legal Chemistry."* The general outline of the processes are as follows:—Total ash—five grms. of the sample are placed in a platinum vessel and heated over a Bunsen burner until complete incineration has been accomplished. The vessel is allowed to cool in a desiccator, and is then weighed as quickly as possible.

Ash Insoluble in Water.—The total ash obtained, as previously mentioned, is washed into a beaker and boiled with water for a considerable time. It is then placed upon a filter, and the insoluble residue washed, dried, ignited, and weighed.

Ash Soluble in Water.—The proportion is obtained by deducting the ash insoluble in water from the total ash. The ash insoluble in water is boiled with dilute hydrochloric acid, and the residue separated by filtration, washed, ignited, and weighed.

The Extract.—Two grms. of the carefully sampled tea are boiled with water until all soluble matter is dissolved, water being added from time to time to prevent the solution becoming too concentrated. The liquid is poured upon a tared filter, and the remaining insoluble leaf repeatedly washed with hot water until the filtered liquid becomes colourless. The filtrate is now diluted to a volume of 200 c.c., and of this 50 c.c. are taken and evaporated in a weighed dish over the steam bath until the weight of the extract remains constant. Its weight is then determined.

Insoluble Leaf.—The insoluble leaf obtained in the preceding operation, together with the weighed filter, is placed in an air-bath and dried for at least eight hours, at a temperature of 110° C. Its weight is then determined.

It should be noted that in the foregoing estimations the tea is taken in the ordinary air-dried condition. If it be desired to reduce the results obtained to a dry basis, an allowance for the moisture present in the sample (an average of eight per cent), or a direct determination of the same must be made.

The opium assays rank next to those of tea in point of number. All of this substance that is brought into the United States must contain at least nine per cent of morphine. Frequently a cargo containing twenty or more samples are received at the appraiser's store. Indeed, during the month of April, 1885, there were 108 estimations of morphine received. Hence, it was necessary to adopt some method which would comply with the following conditions: rapidity of manipulation, simplicity of apparatus, and accuracy of results. Mr. Wainwright undertook the solution of this problem, and after careful study of the different processes in use, adopted that recommended by Dr. E. R. Squibb.† Besides careful sampling, in fact, this is one of the most important details to be considered, the assay consists of three distinct operations: the preparation of the extract, separating the morphine, and treatment of the separated alkaloid.

Preparation of the Extract.—Ten grms. of the sample are introduced into an ordinary six-ounce wide-mouthed bottle, fitted with a good cork. Then 100 c.c. of boiling water are added, the bottle tightly corked, and after frequent hard shaking allowed to stand from twelve to twenty-four hours (generally over night). The extract is then decanted upon a filter, 50 c.c. of hot water is added, the bottle again well shaken, and its contents transferred to the filter. When the liquid ceases to drop the contents of the filter are put back into the bottle, again shaken with 50 c.c. of water, after which it is thrown upon the same filter, and washed until the water comes through colourless. The filtrate is now concentrated over a water bath to a volume of about 25 c.c. This extract is then transferred, using as little water as possible, into an accurately tared Erlenmeyer flask, provided with a tight cork and allowed to stand.

Separating the Morphine.—After cooling, 10 c.c. of 95 per cent alcohol are added and the flask agitated; then sufficient ether is added, the cork tighly fitted, and the flask again well shaken. After this, and before the ether has had time to separate, about 4 c.c. of a 10 per cent solution of ammonium hydroxide is poured in. The flask is then well shaken until the crystals of morphine begin to separate. It is then set aside in a cool place until the alkaloid has entirely separated (generally over night).

Treatment of the Separated Alkaloid.—When the separation is complete, the upper portion of the ethereal fluid is carefully decanted through a tared filter; then 20 c.c. of ether is poured into the flask, and, after slight agitation, carefully poured on the filter. The paper is washed with more ether, applied drop by drop around the edges. The crystals remaining in the flask are then washed upon the filter with cold water, and the washing continued until the filtrate comes through colourless. The filter and contents are then pressed between folds of blotting-paper and dried in an air-bath at 100° C. The tared flask is likewise dried and weighed if any crystals adhere to its sides. Weighing and calculating results complete the operation.

In the analyses of lead ashes and alloys the usual methods of separation, recommended by Fresenius and others, are used. The copper matte estimations are made by the ordinary electrolytic method. In the case of ores the same process is employed. With iron oxides a simple determination of the oxide is all that is considered necessary. This is accomplished by means of precipitation with ammonium hydroxide and subsequent separation. Under this head may be included various pigments, such as colcothar, crocus martis, Indian red, and similar compounds; also the polishing powders with various names, on which duty is levied according to the amount of iron oxide which they contain.

Examination of substances containing alcohol consists in determining the amount of absolute alcohol by distillation, and then taking the specific gravity of the distillate. The examination of glycerin is somewhat crude, although, in the hands of those who have had experience in the matter, it becomes very easy to determine whether the sample under inspection is raw or refined, as the duty is regulated according to the quality of the glycerin. The assay includes the following tests:—The reaction with litmus-paper; Determining the specific gravity; The examination of the precipitate with silver nitrate, lead acetate, barium chloride, and ammonium oxalate. The determination of the carbonaceous residue and of the mineral ash also are made. The vinegar determinations which are daily made consist in taking the specific gravity of the sample, and in ascertaining the number of grains of potassium bicarbonate required to neutralise one troy ounce of the fluid. Phenolphthalein has been used as an indicator, and gives every satisfaction.

The examination of kainit, potassium sulphate, and manure salts is frequently required on account of the large amounts of these substances imported from Germany. The method* followed consists in dissolving ten grains of the sample in 200 c.c. of water, and, after diluting to 1000 c.c., filtering; 25 c.c. of the filtrate is diluted to 150 c.c., and a slight excess of barium chloride is added; then, without filtering, add barium hydroxide in slight excess. Filter and wash until the precipitate is free of chlorides. To the filtrate add 1 c.c. of strong ammonium hydroxide, and then a saturated solution of ammonium carbonate until excess of barium is precipitated. Add in fine powder 0·5 of a grm. of pure oxalic acid, or 0·75 grm. of ammonium oxalate. Filter, wash, and evaporate the filtrate to dryness. Then ignite until all volatile matter

* "Tea and its Adulterations," p. 134, *et seq.*
† "Ephemeris," vol. 1, p. 15.

* See "Methods of Analysis of Commercial Fertilizers," Bulletin No. 7, Department of Agriculture. Washington, 1885.

is driven off. The residue is digested with hot water, filtered, and diluted to 30 c.c. To the filtrate two drops of strong hydrochloric are added, and then 10 c.c. of a solution of 10 grms. of platinum chloride in 100 c.c. of water. The mixture is evaporated to a thick syrup over a water bath, treated with 85 per cent alcohol, well rubbed with the stirring rod, washed with 85 per cent alcohol by decantation, collected on a filter, again washed with alcohol, dried, and weighed.

In addition to the foregoing, the chemist is called upon to determine numerous compounds, which have been entered under the names of "chemical salts," "medicinal preparations," "acid bases," "no name," and similar titles. A curious illustration of the latter occurred in an undesignated compound, which was apparently a mixture of chalk and some organic body. The determination of the character of the latter for some time baffled the examiner, until, after tasting it, the numbness produced on his tongue suggested cocaine, a theory which was subsequently corroborated by the proper tests.

Questions of the gravest importance, involving thousands of dollars of duty, are often referred to the laboratory for decision. The opinion given is sometimes questioned, and its correctness must be defended in open court. This requires considerable research on the part of the chemist, as well as a high degree of competency. During recent years the most notable of these cases was a series involving the correctness of the chemist's report of the analysis of colcothar, and later several questioning the accuracy of his results in analyses of bone-black. Frequently subjects dealing with chemical technicalities are referred to the chemist for consideration. Of this nature was the important decision which turned on the question as to whether Apollinaris water was natural or artificial. These questions, though usually of less prominence than that previously referred to, are sent to New York from every port of entry in the United States; and, according to the report received, the amount of duty to be levied is fixed. From the description thus given of the work accomplished by Dr. Battershall and his assistants, some idea of the scope and magnitude of the United States Laboratory may be obtained.

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 280.)

14. *Test for Iron and Manganese.*

It does not appear to me to be necessary to use the microscope in testing for iron, inasmuch as the colour of the fine precipitate caused by ferrocyanide of potassium in solutions of ferric salt is quite as easily detected with the naked eye as it is under a magnifying power of two hundred times.

The test for manganese, which is based on the formation of a manganate by fusion with sodic carbonate exposed to the air, offers a means so certain and so characteristic for detecting traces of this metal that a microscopic test is quite superfluous.

15. *Test for Metalloids.*

The tests for some of the metalloids can be made by inverting some of the reactions already described (sulphur according to § 13; and phosphorus according to § 12). I have been compelled to devise special tests for the detection of chlorine, fluorine, boron, and silicon.

16. *Test for Sulphur.*

In testing for sulphur it is first of all necessary to transform it into a soluble alkaline sulphate. In cases where we have to deal with sulphides and sulpharsenates, we must oxidise them by fusing them with equal parts of carbonate of soda and nitre; the insoluble sulphates are melted with pure alkaline carbonate.

The resulting mass is broken up into a coarse powder: this is moistened with a drop of water, and a drop of a mixture of chloride of aluminium and hydrochloric acid is then added, with a little chloride of cæsium. We then proceed as has been previously indicated (§ 13), and we find the first crystals of cæsium alum close to the glass rod.

17. *Test for Phosphorus (and Arsenic).*

The insoluble phosphates are treated in exactly the same manner at first as the insoluble sulphates. As a reagent we use a concentrated solution of chloride of ammonium and a grain of crystallised sulphate of magnesia (or better still kieserite, as it dissolves more slowly), and after that we proceed in the manner just now referred to in § 12.

The manner of preparation is the same for arsenides as it is for sulphides; that which serves to transform insoluble sulphates into alkaline sulphates, which of course are soluble, applies equally to insoluble arseniates. The microscopic crystals and the general crystalline character of ammonio-magnesic arseniate resemble, and may even be mistaken for, those of the corresponding phosphate. Experiments undertaken with the idea of obtaining a characteristic colouration on the surface of the crystals of the arseniate by means of sulphuretted hydrogen and nitrate of silver, did not give any satisfactory results.

When we have to try for arsenic in the presence of phosphorus we can effect a sublimation by heating a mixture of the substance with soda and potassic cyanide. We can give a much greater sensitiveness to this operation by following the instructions which will be given later on (in § 21) when we are treating of the test for water.

The reaction with ammonic molybdate and nitric acid has the great fault of applying equally to phosphoric and arsenic acids. It possesses no advantages above the reaction just described, and it is extremely slow; we are, in fact, obliged, in dilute solution, to wait until the edge of the drop is dry. For this reason I prefer using chloride of ammonium and sulphate of magnesium. In conclusion, all that has been said about potassic phospho-molybdate applies also to ammonic phospho-molybdate.

18. *Test for Chlorine.*

The test for chlorine under the microscope cannot be made with nitrate of silver, as chloride of silver forms opaque clots and tufts, which have no particular characteristics, and might easily pass unobserved in cloudy solutions.

Mercuric nitrate under the same conditions gives rise to the formation of a crystalline precipitate composed of fine characteristic needles, which can be readily distinguished from the needles formed by gypsum; unfortunately these crystals change spontaneously after two or three minutes, and break up completely, forming particles of such minuteness that a magnifying power of 600 times is barely sufficient to enable one to distinguish that their transverse section is quadratic.

The salts of lead give crystalline needles distinctly formed and strongly refracting, with hydrochloric acid and soluble chlorides; but we cannot make use of this reaction when the chlorides are accompanied by sulphates. When we have effected the decomposition of the mineral by fusion with soda we can, in the majority of cases, advantageously use plumbic nitrate dissolved in dilute nitric acid as a reagent to indicate the presence of chlorine. The crystals of plumbic chloride separate from a cold solution in the manner which is familiar to everybody. The rhombs of plumbic chloride are about 10 to 15 microns in length; the dimensions of the dendrites vary considerably. The best plan of testing to be followed is that already described in § 16.

In the presence of sulphuric acid or of sulphates plumbic nitrate should be replaced by sulphate of thallium, a re-

agent which I much prefer to the salts of lead on account of the greater sensitiveness of its behaviour towards chlorides, and because of the immutability of the crystals of chloride of thallium.

In cases where we have attacked the mineral by fusing it with soda, we use sulphate of thallium dissolved in dilute sulphuric acid, following the plan just described (§ 16). In the majority of cases, however, it is preferable to use concentrated sulphuric acid, and to follow one of the two methods I am now about to describe. According to the first we decompose the mineral by heating it to a moderate temperature with as small as possible a quantity of concentrated acid, then add an equal volume of water, and then place a grain of sulphate of thallium in a small drop of water placed in contact with the liquid to be tested. The crystals of chloride of thallium then form in the immediate neighbourhood of the sulphate of thallium.*

All these operations are conducted on a glass plate. According to the second method we heat the mineral with a little rather stronger sulphuric acid in a platinum crucible and dissolve the hydrochloric acid, which is given off, in water. To effect this we must place a cover on the crucible with a small drop of water on its underneath side. Tnis is cooled by putting a large drop of water on the top. After this micro-chemical distillation has been effected, the upper drop of water is removed by means of a capillary tube; we then turn over the cover and place it on the glass plate; we then place a small grain of sulphate of thallium in the drop. The crystals of chloride of thallium are not long in making their appearance; they consist of octahedra, and of combinations of octahedra with dodecahedra, having a diameter of 10 to 15 microns. Under a low power microscope, and by transmitted light, these crystals, on account of their high refrangibility, appear almost black, while they are white in direct light. This property, and still more the tendency to form triplets, or double twins like a cross, gives them a special character, and enables us to find very small and thinly distributed crystals.

The average length of the cruciform crystals is about 50 microns, but some are as much as 100 microns; they are very regular in formation, and closely resemble the cruciform crystals of magnesite which are found in scoria. The sensitiveness of the reaction depends on the quantity of acid contained in the liquid. It is for this reason that the crystals form much more quickly and in larger quantity when we use the second method than when we use the first. If the acid is in too great excess we can neutralise its baneful influence by adding an acetate, as has been already shown (§ 13).

Notwithstanding the loss, which is inevitable in attacking the mineral, and during the distillation of the hydrochloric acid, I have obtained a distinct reaction with a quantity of the acid corresponding to 0·004 m.grm. of chloride of sodium.

Bromide of thallium is hardly distinguished under the microscope from the chloride; the crystals have exactly the same formation in each case, and the colour is also the same; the dendrites of the bromide, however, are not so pronounced, and are only about 15 to 25 microns in length.

The iodide and fluoride of thallium are, on the contrary, quite distinct from the previous named salts. The crystals and the rosettes of the iodide, although of the same form as the chloride, are much smaller, the largest being only 20 microns in length, and they are of so strong a yellow colour that the tint can be distinguished in crystals of only 3 microns in length. By transmitted light these crystalline grains appear nearly black. The fluoride is more soluble than the other haloid salts of thallium; it crystallises in very flat octahedra, and often forms combinations of the octahedron with the cube and the dodecahedron, when they even have the appearance of tablets of a very pale tint, and are very transparent compared with the chloride of thallium.

(To be continued). 203

* We also obtain very good results by inverting the reaction for potassium. A mixture of platinic sulphate and sulphate of potassium renders very good service, but it is preferable to use a mixture of the acetates. This reaction is not more sensitive than that which is based on the use of sulphate of thallium, but it is much easier to observe.

INFLUENCE OF COPPER ON THE ESTIMATION OF SULPHUR.

By WM. F. BRUGMAN,
Chemist, Scranton Steel Company.

When steel, pig-iron, or iron, is dissolved in HCl the sulphur present is given off as H_2S, a trace at most escaping the action of the solvent. Several devices are employed for absorbing and estimating the liberated H_2S, but all presuppose not only the completeness of the above reaction, but the assumption that all the H_2S is eliminated from the decomposing liquid. This might indeed be questioned when metals precipitable by H_2S are present in the material under examination, and reasoning from analogy one might expect that some of the sulphur would become inert through combination in the decomposing flask with such elements if present. Copper, on account of the comparative frequency with which it is encountered, merits our consideration in this respect more than the other members of this group, and some diversity of opinion seems to exist as to the accuracy of the "H_2S method" when this element is present.

G. Craig* shows that in the presence of copper no loss of sulphur is incurred. H. Rocholl† reaches the opposite conclusion, and after a series of experiments states that the loss is proportional to the amount of copper present. M. Troilius,‡ in a paper on the determination of sulphur in steel, says—"As for sulphur being retained in the residue as CuS, when the amount of copper is considerable, this is a matter of rare occurrence, and the presence of 1 per cent of copper or so would certainly be reason enough for a special searching investigation, not necessary during running work. A steel containing 0·30 per cent Cu gave 0·160 per cent S, both by the aqua regia and bromine ('H_2S method'), and a spiegel with 9 per cent Mn and ½ per cent Cu gave traces of S by both methods." Again, he says§ "If the steel or iron contain much copper, —say more than 0·250 per cent, or other elements that are precipitated by H_2S in acid solution,—the bromine method is apt to give too low results."

A large proportion of the steels and pig-irons analysed at this laboratory contain high copper, and in view of the opinions expressed above I have deemed it imperative to institute a few experiments to satisfy myself as to the accuracy of the method‖ used under these conditions.

	Per cent S.
A sample of pig-iron, containing 0·835 per cent Cu, gave by the "aqua regia method" ..	0·228
Fused with Na_2CO_3 and seppt., gave	0·226
Sulphur in same iron by "H_2S method" ..	0·228
A pig-iron, free from Cu, gave "H_2S method"¶	0·025
Determination repeated, after adding 0·035 Cu in the form of chloride, found	0·023
Sample of steel, containing 0·70 per cent Cu, gave ("H_2S method")	0·086
Repeated, adding to drillings 0·054 CuO, gave	0·087
Sample of steel, free irom Cu, gave, same method	0·046
Same, after adding 0·054 CuO, gave, same method	0·048

* Chemical News, xlvi., 199 and 272.
† *Ibid.*, xlvi., 236.
‡ *Inst. Mining Eng.*, xii., 507.
§ "Notes on the Chemistry of Iron."
‖ *S. of M. Quarterly*, v., No. 1.
¶ Five grms. used.

In addition to the above I have repeatedly examined the solution remaining in the flask, and have never been able to detect a weighable amount of sulphur. These results show that copper exercises no deleterious influence, and can safely be disregarded when present to the amount of 1 per cent.—*School of Mines Quarterly.*

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 282.)

Mr. EDGAR RICHARDS then presented a paper entitled—

Notes on a Comparison of the Official and Nitric Acid Methods for Phosphoric Acid Determination.

A discussion having arisen in the laboratory of this department in regard to the use of nitric acid as a solvent in the determination of total phosphoric acid in fertilisers, I undertook some comparative experiments to determine the following points:—

Whether there was any difference in the results obtained between the two methods; and

Whether previous ignition with or without the addition of magnesium nitrate was necessary.

Nine samples of fertilisers were taken, eight of which were received from the committees of this Association. viz., Nos. 1—5, the samples sent out in 1885 by the Potash Committee, and Nos. 7—9, those received this year from the Phosphoric Acid Committee. No. 6, the remaining sample, was the one that occasioned the discussion.

The Tables below give the method of analysis followed and the results obtained.

The analyses show that the treatment of magnesium nitrate may be omitted, as it does not affect the results one way or the other; and the danger of losing an analysis by its spattering on ignition is avoided and time saved in

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

TABLE I.

Official Method.		*Nitric Acid Method.*	
1.	2.	3.	4.
Take 2 grms.	Take 2 grms.	Take 2 grms.	Take 2 grms.
Add 5 cubic centimetres Mg $(NO_3)_2$ and dry.			
Ignite.	Ignite.	Ignite.	
Heat with 15 c.c. HCl.		Boil with 10 cubic centimetres HNO_3.	
Filter and dilute to 200 c.c.		Filter and dilute to 200 c.c.	
Take 25 to 50 c.c. in duplicate.		Take 25 to 50 c.c. in duplicate.	
Neutralise with NH_4OH.		Neutralise with NH_4OH.	
Add 15 grms. Am. nitrate.		Add 50 to 100 c.c. Am. molyb. sol.*	
+ 50 to 100 c.c. Am. molyb. sol.*		+ 10 c.c. acid Am. nitrate sol.†	
Heat for 1 hour at 60° C. with occasional stirring.		Heat for 1 hour at 80° C. with frequent stirring.	
Filter and wash with dilute Am. nitrate sol.		Filter and wash with dilute acid Am. nitrate sol. (1 to 1).	
Dissolve with NH_4OH.		Dissolve NH_4OH dilute.	
Neutralise with HCl. Cool.		Neutralise with HCl. Cool.	
Add 5 to 10 c.c. Mg mixture, and 30 c.c. dilute NH_4OH.		Add 5 to 10 c.c. Mg. mixture,* and 5 c.c. NH_4OH.	
Let stand 1 hour.		Let stand 1 hour.	
Filter, wash, ignite, and weigh $Mg_2P_2O_7$.		Filter, wash, ignite, and weigh $Mg_2P_2O_7$.	

* Fresenius's formula.

† 650 c.c. HNO_3, sp. gr. 1·2.
70 c.c. NH_4OH, strong.
330 c.c. Water.

TABLE II.—*Comparison of Official and Nitric Acid Methods for* P_2O_5.

	(1) Low-grade superphosphate.	(2) High-grade phosphate.	(3) Tankage.	(4) Tobacco stems and ground bone.	(5) Ground bone.
(1) Official method	9·776 9·750	11·324 11·337	12·079 12·027	11·567 11·464	20·319 20·268
(2) Official method, except treatment with $Mg(NO_3)_2$	9·724 9·801	11·413 11·490	12·232 12·283	11·388 11·362	20·216 20·216
(3) HNO_3 method	9·801 9·776	11·439 11·490	12·233 12·207	11·618 11·567	20·396 20·421
(4) HNO_3 method, except ignition	9·827 9·852	11·464 11·516	12·156 12·104	11·362 11·336	20·268 20·268
Highest	9·852	11·516	12·283	11·618	20·421
Lowest	9·724	11·324	12·027	11·336	20·216
Difference	0·128	0·192	0·256	0·282	0·205

	(6) Tankage.	(7) South Carolina rock.		(8) Navassa.		(9) South Carolina and Navassa mixed.	
(1) Official method	9·007 8·982	19·103 19·026	19·039 19·026	18·489 18·451	18·361 18·399	17·875 17·875	17·785 17·530
(2) Official method, except treatment with $Mg(NO_3)_2$	8·879 8·879	18·758 18·860		18·604 18·553		17·734 17·713	
(3) HNO_3 method	8·995 8·995	17·313* 17·350*	17·043 17·018	18·374* 18·220*	17·657 18·092	16·897 16·813	16·828* 16·851*
(4) HNO_3 method, except ignition	8·956 8·892	19·090 19·244		18·886 18·962		18·349 18·297	
Highest	9·007	19·244	19·244	18·962	18·962	18·349	18·349
Lowest	8·879	17·018	18·758	17·657	18·361	16·813	17·530
Difference	0·128	2·226	0·486	1·305	0·601	1·536	0·819

to destroy all organic matter.

The nitric acid method without previous ignition of the fertiliser gives results that agree very closely with the official method, and though the solution may be highly coloured yet the organic matter is sufficiently oxidised to be harmless in the analysis. The solution is obtained in a very short time, and this method is much preferable for quick and accurate work.

When the fertiliser contains compounds of iron ignition renders these insoluble in nitric acid, and in such cases the destruction of the organic matter may be omitted, or the ignited substance may first be moistened with 2 c.c. hydrochloric acid before the addition of the nitric acid. In the results of Nos. 7 to 9, marked with an asterisk, hydrochloric acid was used, but in no other cases. In the case of South Carolina rock, however, this method of procedure did not give satisfactory results, as the table of analyses shows, but where the previous ignition was omitted the results were very good.

Instead of taking the trouble in the official method to weigh out 15 grms. of ammonic nitrate each time, I make a concentrated solution of the salt, so that 10 c.c. of it are equivalent to the 15 grms.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 2nd, 1886.

W. H. PERKIN, Esq., Ph.D., F.R.S., Vice-President, in the Chair.

MR. Forbes Rickard was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Arthur Henry Downes, M.D., Chelmsford, Essex; George Arthur Goyder, Hawkers Road, Adelaide, Australia; E. Hori, 88, King Henry's Road, Chalk Farm, N.W.; Thomas Burdon Keay, 85, Herrington Street, Sunderland; Charles E. Sohn, jun., 25, Beverley Road, Anerley; James Pim Strangman, Sarno, Province of Salerno, Italy; Jokichi Takamine, Department of Agriculture and Commerce, Tokio.

The following were elected Fellows of the Society:—Messrs. James A. Audley; Chichester A. Bell, B.A., M.B.; John Williams Bevan; Cuthbert Robert Blackett; William B. Bottomley; Ebenezer John Cox; John Fuller; Alexander Galt: Thomas Forest Garwin; Sydney Joseph Harris; George Crompton Holt; H. E. Kirby; Henry A. B. Leissner; James B. L. Mackay; Hugh O'Donoghue Macan, B.A.; James B. Mackintosh; Edward Lloyd Marks; N. A. F. Moos; Herbert Pickington; L. S. M. Pyke; Edwin Quayle; James Schleselman; Harry Silvester; Arthur Turner; Alfred Hughes Twining; William Walker, Jun.; Reginald Williams.

The following papers were read:—

107. "*Bismuthates.*" By M. M. PATTISON MUIR and DOUGLAS J. CARNEGIE,

The authors have attempted to isolate definite compounds of Bi_2O_5, or Bi_2O_4, with K_2O, but without success. They find that very long-continued washing with hot water is required to remove all the potash from the solid products of the reaction between BiO_3H_3 or BiOCl, very concentrated potash solution and chlorine. They show that $Bi_2O_5 \cdot xH_2O$ dissolves in about 100 times its weight of a boiling solution of KOH in a little water, and that yellowish white solids are obtained by nearly neutralising this solution; that these solids may be washed free from potash by boiling water, and that the residual approach the composition Bi_2O_4. They conclude that $Bi_2O_5 \cdot xH_2O$ exhibits feebly acidic functions in its reaction with a large mass of very concentrated potash solution; that under these conditions compounds of the form $xBi_2O_5 \cdot yK_2O$ (or perhaps $xBi_2O_4 \cdot yK_2O$) are probably formed, but that such compounds can only exist, if at all, in presence of large quantities of potash. The authors give reasons for regarding the formulæ given by C. Hoffmann (*Annalen*, ccxxiii., 110) to so-called potassium bismuthates as of little if any value.

108. "*The Action of Inorganic Compounds on Living Matter.*" By JAMES BLAKE, M.D.

The reactions taking place between living matter and inorganic compounds have been investigated by introducing solutions of the substances directly into the veins and arteries of living animals. The action of compounds of more than forty of the elements have been investigated, and the following conclusions have been arrived at:—1st. That the action of these substances on living matter is determined by the electropositive element. 2nd. That their general biological action is connected with their isomorphous relations, substances in the same isomorphous group causing the same biological reactions. 3rd. That in the same isomorphous group the intensity of biological action is determined by the atomic weight; the greater the atomic weight the smaller the quantity required to cause the same amount of biological action, The nature of these reactions is at present undetermined. They most probably are due to contact reactions.

DISCUSSION.

Mr. LLOYD asked whether Dr. Blake had experimented on vegetable matter, and if so, had he obtained similar results? Potash salts appeared to have an action altogether different from that of other members of the group; and it was known also that they affected plants in a special manner.

Dr. STEVENSON said that the subject of the communication was one of great interest, but beset with difficulties. Isomorphous substances often acted very differently upon the animal body, as for instance in the cases of sodium chloride and potassium iodide. Nor would the differences in the atomic weights of potassium and sodium account for the numerous differences in the toxic properties of their salts. Zinc sulphate and ferrous sulphate are isomorphous, but their physiological actions differ greatly. The magnesium group of metals were asserted by the author to act upon the vomiting nervous centre; but whilst this might be conceded as true of zinc and cadmium salts, magnesium salts were not usually regarded as emetics. We know so little of the molecular constitution of bodies in solution, that it was hazardous to reason from the isomorphism of solids to their analogies when in solution.

Dr. LAUDER BRUNTON regarded Dr. Blake as a pioneer in the field of pharmacology, and thought his paper interesting and instructive. The conclusions were, however, rather too general, and the exceptions deserving of more attention than Dr. Blake had given them. Thus the action of the chloride, bromide, and iodide of sodium is determined rather by the electronegative than by the electropositive element; and this is still more the case with the nitrites, all of which, both organic and inorganic, cause dilatation of the blood-vessels. The first-named salts also differ in action, although isomorphous. Again, the toxic power of elements does not rise regularly with their atomic weight, for sodium is less toxic than lithium; but potassium, though more toxic than sodium, is less so than rubidium. The body as a whole is a too complicated reagent, and instead of trying to arrange substances according to their lethal action on the body, a better result would be obtained, he thought, by investigating the effect of different substances on the constituent parts of the body, such as muscle, nerve, and nerve-centre.

Dr. BLAKE, in reply to a question by Mr. Newlands,

stated that he had not experimented on the therapeutic action of boracic acid. He had never before heard of the fact mentioned by Mr. Lloyd, that potash salts exercised an abnormal action on living vegetable matter. The observation was interesting, as of all the substances experimented with the potash salts were the only ones whose biological action was not in agreement with their isomorphous relations. This fact, however, cannot be regarded as an argument against his deduction that analogous actions were produced by isomorphous compounds, which was based upon the results of the examination of the biological action of forty-two other elements, potash salts forming in fact the only exception. The statement made by Dr. Stevenson, that the bromides, iodides, and chlorides of the same base differed in their physiological action, was a mistake, founded on imperfect methods of experimenting. His own experiments, as well as those of other observers, had shown that such was not the case. The remark by Dr. Brunton as to nitrous acid modifying the biological action of the base was undoubtedly true; pyrophosphoric and pyrovanadic acids also exerted a modifying influence, but he had shown that the sulphates, nitrates, phosphates, arseniates, carbonates, acetates, chlorides, iodides, and bromides of the same base caused the same biological reactions when introduced directly into the blood. To the remark of Dr. Stevenson that it was extremely improbable that compounds of such different elements as are contained in the same isomorphous group should cause the same reactions on the various organs, the speaker would only say that, however improbable such a fact might appear, yet experiment had clearly proved that such was the case. As an example that such was the case the action of the salts on the magnesium group was referred to, all of which act on the heart, on the vomiting centre, on the spinal cord, and on the blood, in exactly the same manner.

109. "*Morindin and Morindon.*" By T. E. THORPE, F.R.S., and T. H. GREENALL.

Morindin was discovered by Anderson in the *Surangi*, the roots of *Morinda citrifolia*, which are extensively used in India as a dye-stuff, more especially for dyeing reds, purples, and chocolates. The substance occurs mainly in the root bark, and can be extracted by treatment with dilute alcohol, from which it crystallises in lustrous sulphur-yellow prisms. According to Anderson it has the formula $C_{28}H_{30}O_{15}$.

On heating in closed tubes it is decomposed, and yields a sublimate of *Morindon*, crystallising in long red needle-shaped crystals, to which Anderson assigned the formula $C_{28}H_{20}O_{10}$.

According to Rochleder and Stenhouse morindin is identical with ruberythric acid, $C_{26}H_{28}O_{14}$, and hence morindon is alizarin. Stein (*Journ. Prakt. Chem.*, xcvii., 234) has, however, pointed out several facts which are inconsistent with this supposition. Morindin, like ruberythric acid, is a glucoside, but the product which it yields on hydrolysis, in addition to glucose, is not alizarin.

The authors have examined this question, and in the main their results agree with those of Stein. They extracted morindin from the roots of *Morinda citrifolia*, for a sample of which they are indebted to the Director of the Royal Gardens, Kew, and have compared its properties with those of ruberythric acid, obtained through the kindness of Dr. Schunck. The two substances are not identical, and they behave very differently on hydrolysis. Morindin gives, with sulphuric acid, ferric chloride, and on treatment with nitric acid perfectly different reactions from those afforded by alizarin. The analytical numbers obtained for morindin agree closely with those of Anderson; those obtained for morindon indicate that it is probably trihydroxymethylanthraquinone. The quantity of the two products at the disposal of the authors was insufficient to definitely settle the constitution of the substances. Through the kindness of Mr. Wardle, of Leek, they have obtained a large supply of *M. citrifolia*, and also of *M. tinctoria*, and a further communication on the subject is promised.

DISCUSSION.

Mr. GROVES said that he had assisted Dr. Stenhouse in the investigation referred to; it was not certain whether the species of *Morinda* examined was *citrifolia* or *tinctoria*. Also it was important to remember that a particular constituent might occur in a plant on one occasion and be absent in another sample, grown perhaps under somewhat different conditions. Thus Dr. Stenhouse had discovered *Munjistin* in the sample of munjeet he originally examined, but had altogether failed to find it subsequently in another sample, which, instead, contained another substance.

110. "*The Hydration of Salts: Cadmium Chloride.*" By S. U. PICKERING.

Dr. Nicol has laid considerable weight (CHEMICAL NEWS, 54, 191) upon the fact that Thomsen (*Thermochem.*, 3, 201) has found the heat of hydration of cadmium chloride to be a negative quantity. This being the only inorganic salt which has a negative heat of hydration, the author has repeated Thomsen's work. Two samples were prepared of anhydrous salt, one at 200° C., and the other fused; they both gave numbers practically identical with that obtained by Thomsen, at 18°, −3011 cal. The hydrated salt also gave a number very nearly the same as Thomsen's, −760 cal., but was found to be a monohydrate instead of a dihydrate. Thomsen, therefore, in describing the salt used by him as containing $2H_2O$, has evidently made some error. The monohydrate is obtained upon evaporating a hot solution, and the dihydrate from a cold solution only. The dihydrate gives −2284 cal. on dissolution, and hence the heat of hydration of the salt is $CdCl_2 \cdot H_2O$ (solid) = 1092 cal., and $CdCl_2 \cdot 2H_2O$ (solid) = 2421 cal.

111. "*The Decomposition of Sodium Carbonate on Fusion.*" By S. U. PICKERING.

The author has investigated sodium carbonate in the manner in which he investigated sodium sulphate (*Chem. Soc. Trans.*, 1884, 686), with a view to ascertain whether the discrepancies in the numbers given for its heat of dissolution could be accounted for by its existence in two modifications, as in the case of the sulphate. All specimens dehydrated at temperatures below the fusing point of the salt gave identical numbers, but the fused salt gave a result 200 cal. higher; this was traced to the decomposition of the carbonate: for on exposure to carbon dioxide that gas was absorbed, and the salt then gave a heat of dissolution 600 cal. less than the normal, owing to the formation of some of the acid carbonate, the necessary hydrogen having been derived from atmospheric moisture absorbed by the decomposed carbonate during its preparation. The amount of carbonate decomposed on simple fusion was about 3 *per cent.*

112. "*Derivatives of Tolylbenzene.*" By THOMAS CARNELLEY, D.Sc. (Lond.) and ANDREW THOMSON, D.Sc. (Edin.).

The preparation and properties of the following compounds are described:—

1. α-Monobromotolylbenzene, $C_6H_5 \cdot C_6H_3Br \cdot CH$ = 1 : (2 or 3) : 4, m. p. 127—129°.

2. β-Monobromotolylbenzene, $C_6H_4Br \cdot C_6H_4 \cdot CH_3$ = 1 : 4—1 : 4, m. p. 27—30°.

3. β-Monobromophenylbenzoic acid, $C_6H_4Br \cdot C_6H_4 \cdot COOH$ = 1 : 4—1 : 4, m. p. 193—194°.

4. α-Dibromotolylbenzene, $C_6H_4Br \cdot C_6H_3Br \cdot CH_3$ = 1 : 4—1 : (2 or 3) : 4, m. p. 113—115°.

5. α-Bromophenylbromobenzoic acid, $C_6H_4Br \cdot C_6H_3Br \cdot COOH$ = 1 : 4—1 : (2 or 3) : 4, m. p. 202—204°.

6. β-Dibromotolylbenzene, $C_6H_4Br \cdot C_6H_3Br \cdot CH_3$ = 1 : 4—1 : (3 or 2) : 4, m. p. 148—150°.

7. β-Bromophenylbromobenzoic acid, $C_6H_4Br \cdot C_6H_3Br \cdot COOH$ = 1 : 4—1 : (3 or 2) : 4, m. p. 231—232°.

Terephthalic acid was obtained as the final oxidation product of α-monobromoditolylbenzene, and parabromobenzoic acid as the final oxidation product of β-monobromotolylbenzene, and of α- and β- dibromotolylbenzene.

The two bromophenylbromobenzoic acids, melting respectively at 202—204° and 231—232°, are isomeric and not identical with the dibromophenylbenzoic acid described by Hohn (*Ber.*, 16, 1082) since his acid was obtained from β-dibromofluorene ketone, and is therefore a derivative of 1 : 2 phenylbenzoic acid, whereas both our acids are derived from 1 : 4 phenylbenzoic acid.

113. "*The Amount of Chlorine in Rain-water collected at Cirencester.*" By Edward Kinch, Royal Agricultural College, Cirencester.

Determinations of chlorine in the rain-water collected in a small 5-inch rain gauge, at the Royal Agricultural College, 443 feet above the mean sea-level, have been made continuously since 1870. The rain collected during the six months April to September is kept apart from that of the six winter months October to March; the chlorine is determined in the mixed waters of each six months.

The amount of chlorides in the rain is nearly always greater in the winter months than in the summer months. An abnormal amount of chlorides can generally be traced to storms from the south-west bringing salt spray from the Bristol Channel, about 35 miles distant. Crystals of common salt have been found after such storms on the windows of the College facing west. On one occasion, in September, 1869, Professor Church found chlorine equivalent to 6·71 grains of common salt per gallon in storm-water.

The rain collected during the winter six months, 1872—3, contained an abnormally large amount of chlorine; excluding this period the yearly averages for 16 years, 1870—1885, for the 12 years 1874—1885—86, also the means of the last 12 summer periods and 12 winter periods are—

	Rainfall in inches.	Chlorine per million.	Equivalent to NaCl per acre.
Mean of 12 summer periods to 1885	17·04	3·14	19·91
Mean of 12 winter periods to 1885—86	17·65	3·58	23·56
Average for 16 years (excluding winter 1872—73	33·31	3·25	40·33
Average for 12 years to March, 1886	34·69	3·36	43·47

Lawes, Gilbert, and Warington have found in the rain collected at Rothamsted, as a mean of six years' monthly determinations, 1·99 of chlorine per million, with a mean rainfall of 33·15 inches, equivalent to 24·59 lbs. of common salt per acre. They found the amount of chlorides in the summer months to be less than one-half that of the winter months.

116. "*Some Analogous Phosphates, Arsenates, and Vanadates.*" By John A. Hall, Student in the Laboratory of Owens College.

The author describes a number of phosphates and arsenates corresponding to the vanadates previously described by H. Baker (*Trans.*, 1885, 353); the salts of which an account is given are the following:—

$Na_3AsO_4 \cdot 10H_2O$, Regular
$Na_3VO_4 \cdot 7H_2O$
$Na_3PO_4 \cdot 7H_2O$
$Na_3AsO_4 \cdot 4\frac{1}{2}H_2O$.

114. "*Agricultural Experiments with Iron Sulphate as a Manure during* 1886." By A. B. Griffiths, Ph.D.

The author and others have grown various crops with iron sulphate. Mr. Barlow (Oak Lane Farm, Whitefield, Manchester) after treating a plot of land of ¼ acre with 14 lbs. $FeSO_4$, obtained 5287 lbs. of potatoes, while a similar plot without sulphate only yielded 4891 lbs. Mr. J. J. Hunter (Newcastle-on-Tyne) states that he obtained a crop of turnips grown with $FeSO_4$ as good as a similar crop grown with guano and dissolved bones; he states "it will be far cheaper to use copperas." The author has tested the value of $FeSO_4$ as a manure for hay. Taking two plots of land of the same size, one manured with $FeSO_4$ gave 6962 lbs. of hay (dry), while the other not so manured gave only 3496 lbs. Mr. Barlow has found that iron sulphate is a good manure for onions. The author has grown mangel-wurzel crops with the ordinary artificial manures and top-dressing of nitrate of soda. Two plots were taken of the same size and treated alike as far as artificial manures, quantity of seed used, &c. One plot was dressed with ½ cwt. $FeSO_4$ to the acre. This plot yielded 32 tons of roots; and the other plot (which was treated in precisely the same way, *minus* the $FeSO_4$) gave 26 tons of roots.

The author has grown for the third time bean crops. The land manured with $FeSO_4$ yielded 50 bushels of grain, while the other crop (not manured with $FeSO_4$) gave 30 bushels of grain. He also finds that iron sulphate is a good manure for palms and india-rubber trees. He recommends ½ cwt. of $FeSO_4$ per acre as a top-dressing. The iron sulphate has proved to be an antiseptic agent of great value for parasitic micro-organisms. The paper shows that $FeSO_4$ is apparently a better manure (for certain crops at least) than kainite. With a top-dressing of ½ cwt. of $FeSO_4$ the author obtained 9 tons potato tubers; and with 2 cwts. of kainite as a top-dressing only 6 tons of tubers. In all crops grown with the $FeSO_4$, the albumenoids and soluble carbohydrates are increased. Concerning the ashes of the plants, it is found that when the iron manure has been used, the ferric and phosphoric oxides are increased, and the potash decreased, in the ashes of all crops.

Research Fund.

A meeting of the Research Fund Committee will be held in December. Fellows desiring grants are requested to make application before December 11th.

At the next meeting, on December 18th, the following Papers will be read:—

"Researches on the Constition of 'Azo- and Diazo-derivatives.' I. Diazoamido-compounds." By R. Meldola, F.R.S., and F. W. Streatfeild.

"The Influence of Silicon on the Properties of Iron and Steel." By Thomas Turner.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, December 6th, 1886.

Henry Pollock, Esq.,
Treasurer and Vice-President, in the Chair.

The following were elected Members:—Mrs. Lauder Brunton; Thomas Buzzard, M.D., F.R.C.P.; The Right Hon. Lord Thurlow, F.R.S.; Mrs. Annie S. Tweedie.

Seven Candidates for Membership were proposed for election.

The following Lecture arrangements were announced:—

Prof. Dewar, M.A., F.R.S.—Six Lectures (adapted to a juvenile auditory) on "The Chemistry of Light and Photography." On Dec. 28 (Tuesday), Dec. 30, 1886; Jan. 1, 4, 6, 8, 1887.

Prof. Arthur Gamgee, M.D., F.R.S.—Eleven Lectures on "The Function of Respiration." On Tuesdays, Jan. 18 to March 29.

Prof. A. W. Rücker, M.A., F.R.S.—Five Lectures on "Molecular Forces." On Thursdays, January 20, 27, February 3, 10, 17.

Three Lectures on Thursdays, Feb. 24, March 3, 10.

Prof. F. Max Müller, M.A., LL.D.—Three Lectures on "The Science of Thought." On Thursdays, March 17, 24, 31.

Carl Armbruster, Esq.—Five Lectures on "Modern Composers of Classical Song." On Saturdays, Jan. 22, 29, Feb. 5, 12, 19.

The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S.—Six Lectures on "Sound." On Saturdays, Feb. 26, March 5, 12, 19, 26.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

A Systematic Handbook of Volumetric Analysis; or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases. Adapted to the Requirements of Pure Chemical Research, Pathological Chemistry, Pharmacy, Metallurgy, Manufacturing Chemistry, Photography, &c., and for the Valuation of Substances used in Commerce, Agriculture, and the Arts. By FRANCIS SUTTON, F.C.S., F.I.C., &c. Fifth Edition. London: J. and A. Churchill.

THE fact that a new edition of this work—a fifth—has been called for only four years after the appearance of the former one proves that its utility and its merits meet with wide acknowledgment. The compass of the book has been somewhat extended, although certain matter which found place in the fourth edition has been eliminated. As such is mentioned the systematic volumetric process for the analysis of soils and manures, which is pronounced in the Preface to have been of little value, and the processes for determining the colouring-matter in indigo. These processes, as it was admitted in the last edition, whilst giving fairly accurate results with solutions of pure indigotine, are not trustworthy when applied where they are most wanted,—that is, to the indigos of commerce.

Among the principal additions figures the description of Kjeldahl's process for the determination of nitrogen, which has given "excellent results" in the author's laboratory.

The account of alkalimetric and acidimetric indicators has been enriched by an abstract of Mr. R. T. Thompson's researches (see CHEMICAL NEWS, xlvii.1, 23, 185, and xlix., 32, 119). Of the new indicators described in the former edition, several—*i.e.*, tropæolines OO and OOO, and eosine—have been omitted as not offering any distinct advantages, whilst lacmoid has been introduced into their room.

In the chapter on water-analysis the differences between the two editions are not very important. The determination of free oxygen in water, which many chemists class among the more important data for deciding the quality of a water-supply, which was not described in the former edition, is given on p. 230, quite separate from all the other instructions for the analysis of waters,—an arrangement of doubtful expediency.

The section on gas-analysis contains some very important improvements. Thus we may call attention to the description of Keiser's portable gas apparatus, Hempel's gas-burette, and Lunge's nitrometer, with their respective methods of use; and indeed all the paragraphs on simpler methods of gas-analysis, which are not to be found in the former edition.

Instructions for the volumetric analysis of glycerin, fats, and oils are also introduced for the first time. On the other hand, the process formerly given for the determination of guano has here been omitted.

As regards the determination of tannin the author has somewhat modified his opinion. In the former edition he writes (p. 276):—"Happily since that time Löwenthal has modified it [*i.e.*, his process], so that it may now be said to be worthy of trust, and much more satisfactory than any previous method." In the present edition he tells us—in our opinion with much greater correctness—that this method "is still deficient in accuracy or constancy of results, although much ingenuity and intelligence have been expended upon it." A really trustworthy process for the determination of tannin would be indeed a boon. We doubt, however, whether any such process can be elaborated without a preliminary re-investigation of the tannins.

Two improvements in the getting up of the book deserve notice for their utility. The Index is much more elaborate and copious than heretofore, occupying sixteen columns as against eight in the former edition. In the previous edition the running heading at the top of the pages was simply "Handbook of Volumetric Analysis." In the present we have "Volumetric Analysis" on the left-hand page, and on the right the chief subject dealt with on the page, which of course much facilitates the search for any particular subject.

As a whole this edition is a most decided improvement upon its predecessors.

Les Alcaloides d'Origine Animale (The Alkaloids of Animal Origin). By Dr. L. HUGOUNENG, Professor at the Medical Faculty of Lyon. Paris: Baillière et Fils.

THE author of this work remarks very justly that the discovery of the vegetable alkaloids presented at first considerable difficulties, and that the announcement of their existence and their properties was greeted with no little scepticism. Notwithstanding the wonderful advances of chemical science during the last half century, the recognition of the animal alkaloids encountered similar difficulties and similar doubts. And when the facts were admitted their import was still, and is still, misconceived. As the author remarks, very aptly, to make a discovery is sometimes easier than to understand its import. We shall err greatly if we suppose that the only result of the discovery of the animal bases is the introduction of a new difficulty, a new complication in chemico-legal investigations.

The researches of Selmi, Gautier, Etard, and Brieger and others have broken down an imaginary distinction between plants and animals. They have shown that the production of alkaloids is a general function common to all living cells, whether they be bacteria or the cells of living animals. They throw a new light upon the phenomena of life, of disease, and of death, as well as of putrefaction. Our healthy tissues live anærobically; a part, approximately one-fifth, of the decompositions of which they are the seat, is effected after the fashion of putrid fermentations. "During life, as well as during putrefaction, toxic alkaloids are produced; the kidneys, the bowels, all the natural emunctories have the task of their elimination, without which the organism is poisoned by its own products." Hence, from one extremity of the chain of living beings to the other, biological chemistry henceforth assumes a striking character of unity; bacteria and the cellules of the highest organisms lead the same life, obeying the same laws, and leaving, as the residue of their activity, the same poisonous principles.

Dr. Hugouneng devotes the first portion of his treatise to the bacterian alkaloids and ptomaines. He explains their extraction by the methods of Stas-Otto, of Dragendorff, of Gautier, and Etard. These compounds he classifies as liquid and solid,—a distinction which we meet with in the vegetable bases,—and again as non-oxygenated and oxygenated. He points out the utter untrustworthiness of the reaction proposed by Brouardel and Boutmy for distinguishing the ptomaines as a class from the vegetable alkaloids,—*i. e.*, the reduction of potassium ferricyanide to the ferrocyanide. This reaction is not common to all the ptomaines, and it is observed with morphine, atropine, and certain artificial bases. Hence a general test, distinguishing all ptomaines from all plant-alkaloids and all artificial bases, is still to be sought for. The physiological action approximates closely to that of the pyridic

and hydropyridic bases. The following symptoms are given as resulting from the ingestion of these substances:—Rapid dilatation of the pupil, shortly followed by energetic contraction; reduction, and even abolition, of the excitability of the motor centres; loss of muscular contractility and of cutaneous sensibility, preceded by a brief period of tetanic convulsions; retardation of the movements of the heart, and drowsiness and torpor, frequently terminating in death.

Among the non-oxygenated ptomaines the author enumerates, as established, parvoline, hydro-collidine, two bases analysed though not named, collidine, neuridine, cadaverine, putrescine (which last three are not poisonous), and mydaleine.

The oxygenated alkaloids form a connecting-link between the ptomaines and the leucomaines, and all of them save gadinine are found in normal animal tissues, as well as in putrescent animal matter. Not a few of them, however, are violent poisons, such as neurine and muscarine.

Other alkaloids have been more or less distinctly observed, but they have not yet been isolated, and no account of their reactions, chemical or physiological, is therefore trustworthy.

The author then enters at some length into the toxicology of the ptomaines. He quotes the Commission appointed by the Italian Government to examine this question, who conclude that any given alkaloid may be distinguished from a ptomaine by a number of special characters which he enumerates. One point, however, appears not to have attracted attention. To name it might be indiscreet, as opening a new and unsuspected door for crime.

In the second part Dr. Hugouneng considers the physiological alkaloids, or the so-called leucomaines,—that is, those bases which are formed during life in the animal organism. These he divides into a uric and a creatinic group, besides a number whose composition and mutual relations are not thoroughly understood. Among the latter must rank the active principles of the poison of serpents. Here there is a necessity for much further research, which is impracticable in the United Kingdom on account of the "Vivisection Act."

As an Appendix we find a very complete bibliography of the subject, extending from 1849 down to the present year.

This work, as a fair and precise summary of the present knowledge on a most important subject, cannot be too highly commended.

Price List of Chemical Apparatus and Chemicals, &c. Mawson and Swan, 11—15, Mosley Street, Newcastle-upon-Tyne.

We have here a catalogue of laboratory appliances, which is, in some respects, well worthy of attention. It contains figures, descriptions, and prices of several pieces of apparatus not kept by all dealers, accompanied, in several instances, with instructions for their use. We notice here a set of apparatus for bacteriological researches, Stearn and Swan's patent compound Sprengel pump, a variety of aspirators, Swan's modification of Fletcher's anemometer for measuring air-currents in flues of chemical works, Schiebler's calcimeter, Stead's chromometer, Soxhlet's extraction-apparatus, Hogg's washing flask, Stead's apparatus for gas-analysis, gas-sampler, &c., the apparatus mentioned in Winkler's "Technical Gas Analysis," various nitrometers, Victor Meyer's vapour-density apparatus, and Von Schrœder's apparatus, described in Proctor's work on tannin. There is also an extensive assortment of Fletcher's ingenious appliances for producing heat. On p. 13 in the description of balances a little confusion seems to have arisen from the insertion of decimal points where they are not wanted. Thus, we read of balances to carry 1·000, 1·500, &c., grains in each pan, the weights intended being obviously 1000, 1500, &c., grains respectively.

Among the list of chemicals and reagents figures magnesium sulphydrate, which, on boiling, gives off 35 times it own volume of sulphuretted hydrogen, perfectly free from arsenic, from free hydrogen, and from acid fumes. Its advantages in analytical work, and especially in toxicological investigations, cannot, therefore, be questioned.

We perceive that Messrs. Mawson and Swan likewise issue catalogues of electrical and physical apparatus, of microscopes and other accessories, and of photographic apparatus and appliances.

CORRESPONDENCE.

THE TEACHING OF SCIENCE IN SCHOOLS.

To the Editor of the Chemical News.

Sir,—Sir James Paget at the University of London, is distributing the prizes and certificates to successful candidates at the London centre for the Oxford Local Examinations, on Wednesday, December 1st, took as the subject of his address the Teaching of Science in Schools. Those interested in the matter will find the report in the *Times* of December 2nd. Some quotations from it are given below for the convenience of readers who have not the report at hand.

"But as a man of science himself he was not prepared to admit that the study of classics or of literature was a more efficient instrument for the training of the mind's powers than the study of natural science. But he could not but observe and regret the exceedingly small number of candidates who submitted themselves for examination in science. He thought the schools were making a great mistake in not offering greater encouragement to scientific studies. . . . But the schools were far behind except in a few of the large manufacturing towns. . . . It was therefore of the first importance that science should obtain as full a recognition in schools as any other subject. . . . In the sixth forms science was generally thought a hindrance. Let the schools take warning in time. Science must have its due position assigned to it in our schools, and masters must be appointed equal in power and position to any of the other masters." . . .

"The number of persons of scientific attainments who were in request was constantly increasing. He was a member of the Council of the Health Exhibition, and he remarked on the large number of scientific persons employed. He asked, 'Where do you find them all?' The answer was 'Oh, they are all Germans.'"

With regard to the last statement it is hardly matter for wonder that—with an almost entire absence of technical education, and our public schools overstocking the market with oftentimes indifferent mathematical and classical students, forced into these two grooves by the boycotting of Science—foreign labour competes with a degree of success which proves inconvenient, if not disastrous, to the prospects of a tyro in Science.

Two causes are perhaps worthy of regard whilst considering the failure in School Science-teaching:—

1. That the appointment of the Science-master, and the portion of time allotted to him during the week, are under the control of Classical and Mathematical masters, who regard Science with disfavour, or at best with indifference.
2. That in many cases laymen are appointed as Science masters.

Even the ardour of a boy thirsting for knowledge may be damped by a series of unsuccessful experiments and recourse—*faute de mieux*—to prolonged black-board calculations.

With some notable exceptions, are the names of Science masters (having much leisure for research) found in our scientific journals as often as could be wished?—I am, &c.,

Chronophotographos.

MONSIEUR PASTEUR ON VIVISECTION.

To the Editor of the Chemical News.

SIR,—I enclose you a copy of a letter from M. Pasteur to a friend of mine, Mr. A. H. Bygott, of Lincoln. The letter may interest physiological chemists.—I am, &c.,

A. B. GRIFFITHS, Ph.D., F.R.S. (Ed,), &c.

Lincoln School of Science,
December 3, 1886.

"Paris, le 12 Nov., 1886.

"MONSIEUR,

"Vous trouverez les dernières statistiques publiées sur la rage dans la brochure que je mets à la poste en même temps que cette lettre.

"(Lecture faite le 2 Nov. aux Académies des Sciences et de Medicine à Paris.)

"Pour le charbon c'est environ cinq cent mille animaux, bœufs, vaches, moutons, qui sont vaccinés en France chaque années.

"Vous me demandez en outre mon opinion sur la vivisection :—

"Une pareille question ne devrait pas être discutée. Je condamnerais à l'egal de la femme la plus sensible la barbarie dans la vivisection, mais qui est donc le savant digne de ce nom à qui on pourrait reprocher cette barbarie ? Quant à s'apitoyer sur la mort de quelques lapins lorsque le but est de sauver la vie d'un homme, quant à faire du sentiment devant le sacrifice de quelques moutons pour sauver des moutons et des bœufs par centaines de mille, il n'y a que des insensés qui puissent raisonner ainsi.

"Recevez l'assurance de ma consideration très distinguée,

"L. PASTEUR."

THE FADING OF WATER-COLOURS.

To the Editor of the Chemical News.

SIR,—In the course of some experiments on the action of sunlight on water-colour paints, I found that some mineral colours which did not contain "lead or mercury" were far from permanent when exposed to daylight in the presence of moisture.

The paints experimented on (Windsor and Newton's moist water-colours) were brushed thickly over Whatman's best drawing-paper, and exposed in an atmosphere of dry and of damp air to the action of daylight, one half of each strip being protected from the action of the light.

Cadmium yellow in damp air was entirely bleached on the parts exposed to light in two weeks, but remained absolutely unaltered in dry air.

Prussian blue in damp air was entirely bleached after four weeks' exposure, remaining permanent in dry air.

Yellow ochre faded slightly in the presence of moisture after four weeks' exposure, no change being observed in dry air.

In the case of the organic colours experimented on—viz., crimson-lake, rose-madder, gamboge, and indigo,—the colours were discharged as rapidly in dry as in damp air.

That the fading of cadmium yellow (cadmium sulphide) was caused by oxidation of the yellow sulphide to the white sulphate was shown by treating the bleached paper with water slightly acidified with hydrochloric acid; on adding sulphuretted hydrogen water to one portion of this solution the yellow sulphide of cadmium was precipitated, whilst the other portion gave a white precipitate of barium sulphate on addition of barium chloride.

These experiments have been carried on within the last two months, during which time the light has been very feeble.—I am, &c.,

ARTHUR RICHARDSON.

University College, Bristol,
December 1, 1886.

AN EXAMINATION PUZZLE.

To the Editor of the Chemical News.

SIR,—Permit me to ask A. X. if he has ever heard of such a substance as sodium silicate, or of sodium aluminate, and to inform him that the former of these, if in dilute solution, is not precipitated by hydrochloric acid; the latter, if exactly neutralised, yields a precipitate which is immediately dissolved by excess of acid.—I am, &c.,

A. P. S.

December 4, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 21, November 22, 1886.

On Ammonium-Magnesium Phosphate.—M. Berthelot.—It appears that ammonia, when acting upon trimagnesium phosphate, must produce thermic effects which are very feeble, and precisely of the kind as those which it produces when acting upon the soluble magnesium salts. It is seen at the same time that ammonia, jointly with magnesia, forms, as regards phosphoric acid, a complex base comparable, in its energy, to potassa and soda. Tri-magnesium phosphate in the colloidal state may be rapidly changed into ammonium-magnesium phosphate by the action of ammonia, not because this latter phosphate in the colloidal state exceeds the former in the heat liberated, but because the double phosphate passes more rapidly than the simple phosphate into the crystalline state, with a further liberation of heat.

Actinometric Studies. — E. Duclaux. — Physicists have, for a long time, been seeking for a good process for measuring the chemical action of the sun's rays, which should not be liable to the influence of the thermic action which is generally superadded to the actinic effect. The author utilises, for this purpose, the solar combustion of dilute solutions of oxalic acid. With certain precautions, such as using flat vessels into which the same quantity of acid is always introduced, and taking a solution of 3 grms. per litre, the results are very constant.

New Process for the Volumetric Determination of Zinc-Powder.—F. Weil.—This paper will be inserted in full.

Action of the Alcohols upon Gold-Phosphorus Chloride.—L. Lindet.—The action of the alcohols upon the double chloride of gold and phosphorus gives rise to numerous organic compounds, always containing a molecule of aurous chloride. The author views these compounds as ethers derived from a "chlauroso-phosphorous" acid, $Au_2ClPH_3O_6$. In this paper M. Lindet describes the preparation and properties of the ethylic and methylic ethers of this acid.

On the Russian Petroleums.—J. A. LeBel.—The very volatile portions of the oil of Tschungnalek are absolutely similar to those of the oils of Bakou; the differences becoming accentuated only towards 150°. The fractions of Russian petroleum volatile below 60° do not contain any naphthenes, a fact which confirms the conclusions of Beilstein and Kurbatow relative to their identity with the benzene hydrides.

Neutralisation-Heats of Malic and Citric Acids and their Pyro-derivatives.—MM. Gal and Werner.—It results that the total neutralisation-heat of the pyro-acids, excepting the itaconic, is superior to that of the original acids by about two calories. We see here a

relation analogous to that observed between the monobasic acids and the corresponding acid-alcohols. The pyro-acids derived from malic acid by the elimination of H_2O, and from citric acid by the elimination of H_2O+CO_2, no longer contain the group OH.

Journal für Praktische Chemie.
New Series, Vol. xxxiv., Parts 8 and 9.

Influence of certain Neutral Salts upon the Catalysis of Methyl-acetate of Hydrochloric and Sulphuric Acids.—H. Trey.—The rapidity of the reaction of hydrochloric acid is increased by the presence of its neutral salts; with sulphuric acid the reverse holds good. No numerical relations were manifested for the influence of different salts. If there appears a certain dependence on the atomic weight, no general conclusions could be drawn on account of the small number of the salts examined.

Studies on Diastase.—C. J. Lintner.—Although diastase differs in its composition from the albumenoids, a great similarity to the latter appears in its other properties. As diastase appears in greatest abundance in germination, and as the chemism of germination is, in a certain sense, to be interpreted as a process of oxidation, the conjecture lies near at hand that diastase is an oxidation product of certain protein compounds. That not all protein matters are equally disposed to yield diastase appears from the fact that the seeds of those cereals which are richest in protein do not yield most diastase on germination. The author uses the term "enzymo" as a convenient general name for chemical ferments in contradistinction to the figured or organised ferments.

Contributions to the Chemistry of the Rhodium-Ammonium Compounds.—S. M. Jörgensen.—This valuable paper contains a copious account of the roseo-rhodium, nitrato-purpureo-rhodium, and xantho-rhodium salts. In all these three groups there appears an evident analogy between the cobalt, chrome, and rhodium compounds. But the xantho rhodium salts are far more stable than the corresponding salts of cobalt and chrome. That the nitrous acid of the xantho-rhodium salts cannot be expelled in the cold, even by strong sulphuric acid, and cannot, indeed, be recognised as such, shows with certainty that the xanth-salts are nitrite-purpureo salts, which is confirmed by the very closely approximating crystalline forms of the xantho-fluosilicates and the haloid purpureo-fluosilicates, as well as by the analogous composition of the acid sulphates.

Apparatus for Chemical Laboratories.—Dr. Joh. Walter.—The descriptions of the apparatus cannot be made intelligible without the accompanying figures.

Bulletin de la Société d'Encouragement.
Series 4, Vol. i., No. 9, September, 1886.

Production of Aluminium and its Derivatives in the Electric Furnace. — E. Combes. — From the *Journal of the Franklin Institute.*

Preparation of Ortho-Phosphoric Acid, and Titration of Phosphoric and Arsenic Acid by means of Various Indicators. — A. Joly. — From the *Comptes Rendus.*

MISCELLANEOUS.

Owens College, Manchester.—Mr. Harold B. Dixon, M.A., F.R.S., Fellow of Balliol College, Oxford, has been appointed Professor of Chemistry and Director of the Chemical Laboratories in succession to Sir Henry E. Roscoe, M.P.

Royal Institution of Great Britain—The Christmas Lectures.—A course of six lectures (adapted to a juvenile auditory) on "The Chemistry of Light and Photography" (with experimental illustrations), will be delivered by Professor Dewar, M.A., F.R.S., Fullerian Professor of Chemistry, R.I., Jacksonian Professor of Natural Experimental Philosophy, Cambridge, on the following days, at three o'clock:—Lecture I., Tuesday, December 28th, 1886; Lecture II., Thursday, December 30th; Lecture III., Saturday, January 1st, 1887; Lecture IV., Tuesday January 4th; Lecture V., Thursday, January 6th; Lecture VI., Saturday, January 8th.

Guthrie Memorial Fund.—The following letter is being circulated amongst a large number of scientific men who knew the late Professor Guthrie. We gladly reprint it here, hoping that it may thus meet the eyes of others who will be willing to contribute towards a very deserving object:—"Many of those to whom this letter is sent will feel that by the death of the late Professor Guthrie, F.R.S., whose simple character and wide sympathies endeared him to a large circle of attached friends, they have sustained a personal loss. His time was exclusively devoted to teaching and to scientific research: unfortunately the provision for his family is far from adequate. His widow is anxious to provide for the education and maintenance of her step-children, but the slender income furnished by a policy of insurance settled on herself will not enable her to do this. The ages of the children dependent upon her are twelve, fourteen, and seventeen years, respectively, and their case is the more sad because, until a late period of his life, Dr. Guthrie had every reason to be satisfied that they were sufficiently provided for. Under these circumstances it will be felt by all who value his memory, as well as by those who only knew him through his scientific labours, that any sum which is gathered as a memorial of his life must necessarily be devoted to placing his children as nearly as may be possible in a position they would have occupied but for his untimely death, and to supplementing the provision for his widow. A committee has accordingly been formed, under the presidency of Professor Huxley, to raise a fund for the purposes here indicated. The committee trust that you will allow your name to be added to the list of subscribers, and that they may count upon your active support. Subscriptions may be sent to the Honorary Treasurer, Major C. A. Macgregor, R.E., Science Schools, South Kensington Museum, London, S.W.; or to the Honorary Secretary of the Fund, Mr. C. Vernon Boys, at the same address. Cheques to be crossed 'Messrs. Cox and Co.'"

MEETINGS FOR THE WEEK.

MONDAY, 13th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures). "The Principle and Practice of Ornamental Design," by Lewis Foreman Day.

TUESDAY, 14th.—Institution of Civil Engineers, 8.
—— Photographic, 8.

WEDNESDAY, 15th—Society of Arts, 8. Adjourned Discussion on Dr. C. Meymott Tidy's Paper on "Sewage Disposal."
—— Meteorological, 7.
—— Geological, 8.

THURSDAY, 16th.—Royal, 4.30.
—— London Institution, 6.
—— Chemical, 8. "Researches on the Constitution of 'Azo- and Diazo-Derivatives'—I. Diazo-amido Compounds," by R. Meldola, F.R.S., and F. W. Streatfeild. "The Influence of Silicon on the Properties of Iron and Steel," by Thomas Turner.

ERRATA.—In Report of Physical Society's meeting, p. 282, col. 2—At line 10 from top, for "y" read "γ." Line 23, for "y" read "q." Line 24, for "q" read "y." Line 28, for $t\frac{dx}{dq}$ read $L\frac{dx}{dt}$.

THE CHEMICAL NEWS.

VOL. LIV. No. 1412.

ON THE VOLUMETRIC DETERMINATION OF CHROMIUM.

By W. J. SELL, M.A., F.I.C.,
Demonstrator of Chemistry in the University of Cambridge.

WHEN an aqueous solution of any chromic salt is mixed with excess of potash, to which a small quantity of hydrogen dioxide has been added, the mixture gradually changes in colour from green to yellow, the chromium sesquioxide being converted into chromate. This change is accelerated by heat, and is apparently complete on boiling for a minute or two. The following equation represents the reaction:—

$$2Cr_2(HO)_6+3H_2O+4KOH=2K_2CrO_4+8H_2O.$$

The possibility of utilising this reaction as the basis of a rapid and convenient method for the quantitative estimation of chromium led to an examination being made in the first instance of its application as a volumetric process.

The following is a brief description of the method employed in the examination of this question, together with the results obtained by its application.

A solution containing a known weight of chrome-alum was mixed with sufficient potash to re-dissolve the precipitate first produced, a solution of hydrogen dioxide added, and the mixture boiled briskly for at least fifteen minutes. In the alkaline solution of chromate thus obtained the chromic acid was estimated by the iodometric method (Tulkowsky's modification), though it may be noted that any of the ordinary methods will do equally well.

(1) In presence of alumina. The chrome-alum employed was mixed with about an equal weight of aluminium sulphate.

0·75542 grm. required 51·5 c.c. thiosulphate (each c.c. = 0·00151 Cr) = 10·37 per cent Cr.

0·75542 grm. required 49 c.c. thiosulphate (each c.c. = 0·00163 Cr) = 10·46 per cent Cr.

(2) In presence of zinc. About 1 grm. of zinc sulphate was dissolved in the potassic dichromate used.

50 c.c. N/10 dichromate reduced by sulphurous acid, and, after boiling off excess of the latter, oxidised by method, required 68·6 c.c. thiosulphate, or practically the same volume as by direct titration.

(3) In presence of iron. As ferric salts liberate iodine from potassic iodide it was obvious that some modification of the process, as previously carried out, would be necessitated. The most obvious, perhaps, was to filter off the ferric hydrate after oxidation, and determine the chromic acid in the filtrate by the iodometric method, as before. This was tried with the following results:—

0·60579 grm. chrome-alum, mixed with ferric chloride, required 36·4 c.c. thiosulphate (1 c.c. = 0·001709 Cr) = 10·26 per cent Cr instead of 10·49.

50 c.c. N/10 dichromate, mixed with ferric chloride, reduced by sulphurous acid, and oxidised again by method, required 67 c.c. thiosulphate instead of 68·5 c.c.

50 c.c. N/10 dichromate, similarly treated, required 66·8 c.c. thiosulphate.

A glance at the results obtained so far will show that chromium sesquioxide is completely oxidised to chromate by the foregoing process, and that it may be successfully employed for the estimation of the substance either alone or in presence of salts of aluminium or zinc. In the case of iron the results are low, owing to traces of chromium hydroxide escaping oxidation. The question as to how this difficulty may be surmounted and the examination of the influence exerted by the presence of some other substances is at present engaging my attention.

As a solution of hydrogen dioxide has become a regular laboratory reagent, I may perhaps, in conclusion, point

Weight of Chrome-alum taken.	No. of c.c. Thiosulphate required.	Value of each c.c. Thiosulphate in Cr.	Cr indicated by method.	Percentage of Cr in Chrome-alum found.	Percentage of Cr in Chrome alum calc.
0·60579 grm.	37·2	0·001709	0·06357	10·49	10·49
0·60579 ,,	37·4	,,	0·06391	10·56	10·49
0·60579 ,,	37·6	,,	0·06425	10·60	10·49
0·5677 ,,	39·5	0·00151	0·05964	10·50	10·49
0·75542 ,,	53	,,	0·08003	10·59	10·49
*0·75542 ,,	53·1	,,	0·08018	10·61	10·49
1·0159 ,,	66·6	0·001613	0·10742	10·57	10·49
†0·7889 ,,	56·9	0·00151	0·0859	10·89	10·49

* To this lot, after addition of the oxidising mixture and boiling for ten minutes, a small quantity of platinum black was added and the boiling continued for a further period of ten minutes.

† This lot was only boiled ten minutes after addition of oxidation mixture.

Some additional experiments were made with N/10 potassium dichromate by determining iodometrically the number of c.c. of thiosulphate required for 50 c.c. dichromate, and comparing the result with that obtained from similar portions of the same dichromate solution after reduction with sulphurous acid and oxidation by method.

	Thiosulphate.
(1) 50 c.c. dichromate required	68·5 c.c.
(2) ,, ,, ,, ...	68·6 ,,
(3) Ditto, after reduction and oxidation..	68·6 ,,
(4) ,, ,, ,, ..	68·2 ,,

Two other experiments, in which potash was replaced by sodium carbonate, gave equally satisfactory results.

Attention was now directed to the question as to how far the accuracy of the process was influenced by the presence of other metals. I am unable at present to give a complete answer to this question. The following experiments were made;—

out how this reaction may be utilised in qualitative analysis for the separation of the metals of Group III., viz., those precipitated by ammonia.

The precipitate after washing is dissolved in the least possible quantity of dilute nitric acid and poured into an excess of potash, to which a few cubic centimetres of hydrogen dioxide have been added. The mixture is then boiled for three or four minutes and filtered. The precipitate contains the iron, phosphates, traces of manganese, &c., which is detected as usual. The filtrate, containing all but the least trace of chromium as chromate and the whole of the alumina, is divided into two parts. Part I. is acidified with acetic acid and tested with lead acetate; II. is tested for alumina by NH_4Cl as usual. I may add that test experiments have given the most satisfactory results.

PS. Since the above was sent for publication my attention has been drawn to a paper in the June number of the

Bull. Soc. Chem., by M. Martinon (an abstract of which appears in the last number of the *Journ. Chem. Soc.*), in which the author announces the discovery of the reaction here used, but makes no attempt to utilise it analytically. The bulk of my work was done before the appearance of M. Martinon's paper, but its publication was deferred from time to time in the hope of finding leisure for its completion.—W.J.S.

NOTE ON THE EXISTENCE OF IODINE IN THE FREE STATE IN A MINERAL WATER.

By J. ALFRED WANKLYN.

It has been known for many years that the water of the Woodhall Spa, near Lincoln, is exceptionally rich in bromides and iodides. In the course of an investigation I have made the observation that there is free iodine in this water, and not a mere trace of free iodine, but sufficient to impart to the water a brown colour of considerable depth of tint.

A very instructive experiment is to shake up the water with about one-twentieth of its volume of bisulphuret of carbon, whereupon the brown colour will leave the water and the bisulphuret of carbon will assume a rich violet colour.

The Woodhall Spa is known as a remedy in skin diseases; and no wonder that it should be, since it is a solution of free iodine.

ON THE ESTIMATION OF NICKEL IN MATTES, ORES, SLAGS, &c.

By THOMAS MOORE.

In the following remarks I shall deal only with the separation of nickel from iron, aluminium, chromium, and manganese, the other metals generally accompanying it being those precipitable by H_2S, such as copper, arsenic, antimony, &c., and inasmuch as they may be all got rid of at once by the application of that gas their further consideration is unnecessary.

The main difficulty now remaining is the separation of the nickel from the iron when the latter metal is present in considerable quantities. The most simple process is that recommended by Wöhler, precipitating the solution containing ammonic chloride by excess of ammonia, dissolving the precipitated ferric hydroxide and repeating the precipitation and solution so long as the filtrate contains nickel. By this process all the nickel is, without doubt, obtained, but the repetition of the process requires a considerable time, and the solution is loaded with ammoniacal salts, so that it is necessary to precipitate the nickel as sulphide; a tedious and somewhat uncertain operation. Field's process by boiling the solution of the nitrates with oxide of lead cannot be recommended, as the ferric oxide invariably contains nickel. When the iron is thrown out as a basic salt it is equally necessary to repeat the precipitation, and this gives a very large filtrate to deal with, especially when the basic acetate method is employed, and, moreover, if the solutions are not neutralised to the correct degree the separation may prove a failure.

Now by employing the electrolytic method for the precipitation of nickel, it is not necessary that the iron be completely eliminated, a small quantity having no appreciable influence on the results, as it simply floats as the insoluble oxide in the ammoniacal solution. In those cases, therefore, when only the nickel is to be estimated, I have found it best to precipitate the iron as phosphate from an acetic acid solution, in which it is but very slightly soluble, whilst the corresponding nickel compound dissolves with the greatest of ease. For ordinary technical purposes only one precipitation is necessary, but when greater accuracy is required it is best to repeat the precipitation. The advantages to be obtained by using this method in place of those already mentioned are: no neutralisation necessary, comparatively small filtrate from which the nickel is readily precipitated, and, as a consequence, more rapidly obtained results. The following are the working details of the process which I have employed successfully for a considerable period. Dilute the strongly acid solution (it is immaterial whether sulphuric, hydrochloric, or nitric acid) with water to about 250 c.c., then add an excess of sodic phosphate; if a precipitate forms add acid till it dissolves, raise to the boiling-point, and whilst boiling add sodic acetate solution until the iron is all precipitated as a very pale yellow phosphate; then boil for a minute and filter, wash well with hot water containing a little sodic acetate and acetic acid. The filtrate is now warmed and treated with potassic hydrate and bromine; this throws down the nickel as peroxide, which may be readily filtered off and well washed with hot water. The peroxide is then dissolved off the filter in dilute warm sulphuric acid, from which solution the nickel is electrolytically deposited, first rendering it strongly alkaline with ammonia. A small quantity of ferric hydroxide will probably be found floating in the electrolyte; but this, as already mentioned, does not influence the results. Aluminium remains with the iron, whilst chromium and manganese are to be found in the solution after the deposition of the nickel is completed; the manganese being partially thrown down as peroxide on the anode, whilst the chromium is simply converted into a chromic salt.

Erdington, Birmingham,
Dec. 7, 1886.

ON CERTAIN COLOURED REACTIONS OF TITANIC, NIOBIC, TANTALIC, AND STANNIC ACIDS.

By M. LUCIEN LEVY.

The recognition of the titanic, niobic, and tantalic acids, especially in presence of each other or of stannic acid, is a difficult problem, offering a very limited number of solutions. Every novel specific character of these acids seems, therefore, of importance.

The reagents employed by the author present, for the most part, a phenolic function, and, reciprocally, these latter bodies may, in their turn, be recognised by means of these same mineral acids.

The method of procedure is as follows:—A trace of the reagent (more than ½ m.g.), is placed in a watch-glass, moistened with 8 drops of sulphuric acid, and some granules of the dust of the acid under examination, or of one of its salts are added. In case of stannic acid it is necessary to take a rather large quantity and to add a little water to the mixture. The results obtained are laid down in the accompanying tables. (See next page).

With the exception of those produced by stannic acid all these colours disappear on adding a few drops of water; only the colourations derived from brucine do not yield a colourless solution, the fiery red of the sulphuric solution of brucine remaining after dilution. It is necessary to operate with substances quite free from nitrous or nitric acid; the nitrous vapour liberated by sulphuric acid yields, under the conditions of the experiment, derivatives of a very intense colouration. The table shows that the reagents employed possess one or more phenolic functions, although brucine has not hitherto been regarded as a phenol. Acids, alcohols, aldehyds, acetones, quinones, and alkaloids devoid of phenolic functions do not produce a colouration. This at least,

Reagent.	Titanic Acid.	Niobic Acid.	Tantalic Acid.	Stannic Acid.
Morphine	Crimson	—	Yellow, then brown	—
Codeine	—	Mauve after some time	Watery green	—
Brucine	Slight crimson	Café au lait	Tea-rose	—
Phenol	Brick red	Yellow	Rose, then green, turned to rose by H_2O	—
Naphthol α	Greenish, then violet	Green, then slate-grey	Scheele's green	Amethyst
Naphthol β	Burnt coffee	Gamboge	Greenish	Apple green
Thymol	Garnet	Flesh, then brown	Yellow, green, then olive	Light rose
Resorcine	Flesh, then chocolate	Yellowish	Dirty grey, amethyst, then rose	Orange
Hydroquinone	Crimson	Dirty grey, then violet mauve	Greenish, then yellow	Light yellow
Pyrocatechine	Chocolate	Pearl grey	Greenish	,,
Pyrogallol	Crimson, then brown	Greenish grey	Ditto	Tea rose
Salicylic acid	Flesh, then brick red	Rose, then flesh	Ditto, black the next morning	—
Oxybenzoic acid (meta) ..	Chrome yellow	Light yellow	Very pale yellow	—
Oxybenzoic acid (para) ..	,,	—	Ditto, gooseberry the next day	—
Gallic acid	Brick red	—	—	—

is the result of experiments made with a great number of very various substances.

Certain derivatives of the phenols likewise act upon titanic acid. Thus, phenylsulphuric acid gives an orange and triphenyl a tea-rose colour. Here must also be referred the colours yielded by various carbides. There are formed first sulpho-conjugated compounds; thus, benzene added little by little, gives a reddish-yellow colouration, toluene, a colour of café au lait; and naphthalene a pale violet colour, turning grey.

Silica, alumina, zirconia, and uranium oxide (yellow) under the same conditions, do not give rise to any visible phenomenon.

The coloured reactions above described render it possible to detect titanic, niobic, tantalic, and stannic acids, even if mixed together. The following seems the best procedure:—Ignite the mixed salts in question with ammonium carbonate to destroy every trace of nitric acid; treat a portion of the mixture, as indicated above, with morphine; a crimson colour indicates titanic acid; try the codeine reaction on another part of the mixture; a mauve colour betrays niobic acid: try a third portion with resorcine; an amethyst violet (or green, if there is much of the two acids present) shows tantalic acid; a last part of the mixture, if it gives an amethyst violet with α-naphthol and water, reveals stannic acid.

These same reactions furnish, likewise, several methods for the detection of certain phenols. For instance, in a mixture of morphine and codeine, titanic acid shows even a trace of morphine and niobic acid indicates codeine.—*Comptes Rendus*, ciii., p. 1074.

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Continued from page 290.)

19. *Test for Fluorine.*

In testing for fluorine it is first necessary to transform it into hydrofluosilicic acid: in order to effect this we first separate it in the form of silicic fluoride by distilling with concentrated sulphuric acid; in some cases it is necessary to add a little silicic acid or powdered glass.

Certain fluoric silicates, such as the topaz (tourmaline) and pyknite, ought to be first of all attacked by fusion with carbonate of soda (two parts of the latter to one part of the mineral). Fusion with hydrosulphate of potash, or with the salt of phosphorus, might serve equally well to separate the fluorine from the mineral, but the temperature necessary to effect this decomposition is too high.

The silicic fluoride which is formed is absorbed by dilute sulphuric acid, which does not evaporate so quickly as pure water; instead of the cover which was used in the distillation of hydrochloric acid, we here make use of a small thin platinum cover, such as has been already described (§ 6), with the convex side placed downwards. The portions which have been melted with soda are next warmed, and evaporated to dryness with acetic acid before the addition of sulphuric acid. In this manner we prevent the loss which is caused by effervescence, while the fluoride remains intact; the acetic acid vapours which develop later on, during the distillation with sulphuric acid, are very favourable to the complete condensation of silicic fluoride. During the first half of the time necessary for the transformation of the fluorides into sulphates the matter must be kept warm; the drop of water which has served to cool the cover is removed, and the drop containing the fluoride is placed on a plate of varnished glass, or a polished plate of heavy spar, which answers the purpose better.

We can easily make plates of heavy spar suitable for this experiment by taking the pieces obtained by following the cleavage planes, about 1·5 to 2 c.m. long and 2 or 3 m.m. thick, and sticking them to plates of glass by means of Canadian balsam, so as to avoid the cracks which would ensue in the second cleavage plane; they are then rubbed on a very smooth oilstone, then with water, and after that with oil, and finally polished by rubbing with a piece of very soft leather and oxide of tin.

I use chloride of sodium as a reagent, and I put 1 or 2 m.grms. of the solid salt into the drop under examination. If the hydrofluosilicic acid is not too dilute, we first see forming elegant rosettes with six points, measuring about 100 microns; later on we notice the appearance of hexagonal tablets, and prisms combined with pyramids, of about 25 microns in length. They are slightly cloudy in appearance and of a delicate rose-colour.

The potassic fluosilicate is much less soluble, but much more difficult to recognise, on account of its extraordinary transparency.

By following this method exactly as has been described I have succeeded in obtaining satisfactory results with 0·0036 m.grm. of fluorine.

20. *Test for Silicon and Boron.*

The test for silicon and boron is conducted in the same manner as that for fluorine, the only difference being that in the first case we use hydrofluoric acid conjointly with sulphuric acid, and we can only use plates of varnished glass or a plate of heavy spar, while in the test for fluorine

we can in cases of necessity employ ordinary plates of glass.

The method of distillation is the same as in the case of fluorine (§ 19). We make use of sodic chloride as the reagent, when we only have to try for one of the two above-named elements; it gives, with hydrofluoboric acid, precisely the same hexagons and the same results as it does with hydrofluosilicic acid. The reaction enables us to detect with facility 0·08 m.grm. of silicic acid and 0·04 m.grm. of boric acid.

In the greater number of cases we have to try for boron when mixed with a preponderating quantity of silicon (axinite, datholite, tourmaline); in these cases chloride of sodium will not answer. After having made several unsuccessful attempts, I succeeded in finding two very distinctive reactions, which I will now give, for want of other more suitable means.

The solution of calcic fluosilicate, evaporated down until very concentrated, gives small lenticular-shaped masses, of about 20 microns in length; the fluoborate, under the same conditions, appears in the form of short rhombic prisms, which generally offer themselves to our view with their section transversal; the rhombs, which have tolerably sharp angles, are about 10 to 15 microns in length and 8 to 12 microns in width. The reaction is exceedingly useful when we do not have to deal with sulphuric acid at the same time as hydrofluoboric and hydrofluosilicic acids.

The potassic fluosilicate gives crystals belonging to the regular system. They are octahedra and cubes combined with octahedra; the potassic fluoborate appears, when the acid is sufficiently concentrated, under the form of narrow-pointed strips, and afterwards as rhombs, the length of whose diagonals are in the proportion of 2 : 3. Their length varies from 30 to 50 microns. The two obtuse angles are often truncated; sometimes, also, the larger crystals show indications of a truncated pyramid. The potassic fluoborate crystallises after the fluosilicate; it is necessary to pay attention to this fact when searching for boron in the presence of a large quantity of silicon.

If we were to add the potassic chloride immediately to the product obtained by the distillation with sulphuric and hydrofluoric acids, it is very possible that we should not perceive the fluoborate; in any case we should have some trouble in recognising the small number of these crystals amongst the large quantity of octahedra of potassic fluosilicate. I therefore recommend the elimination of the greater part of the silicon. To effect this we warm the mixture of the mineral with sulphuric and hydrofluoric acids for a space of time long enough to drive off the greater part of the silicic fluoride, which can be absorbed with water or dilute sulphuric acid, so as to enable us to test for hydrofluosilicic acid in the manner already described in § 19. We repeat the operation after the addition of a fresh quantity of hydrofluoric acid; we increase the temperature little by little until the vapour of sulphuric acid commences to come off, because the boiling-point of hydrofluoboric acid is almost as high as the boiling-point of sulphuric acid.

The product of the second distillation is heated up to 120° C.; after waiting a few minutes, a drop of water is added, and then the potassic chloride. If the rhombic crystals of potassic fluoborate do not show at once, it is not a proof of the absence of boron; we should in every case wait until the complete desiccation of the drop.

21. *Test for Water.*

In some special cases it may be very necessary to prove the presence of water in a very small specimen of the mineral. By proceeding carefully we can detect the presence of a tenth of a m.grm. of water by following a plan analogous to that employed in blowpipe analysis. The essential point in this method is to concentrate the small quantity of water into as small a space as possible, and to prevent, at the same time, any loss of that present or the introduction of any water vapour from without.

For this purpose I employ tubes having an inside diameter of 2 m.m. and 10 c.m. long, drawn off to a fine point of 0·5 m.m. diameter and 2 c.m. long. After having warmed the tube from one end to the other, and having passed air through it, by sucking through an india-rubber tube attached to the other end, the fine end of the tube is sealed up in the lamp. The fragment of mineral is put in while the tube is still warm, and the tube is then sealed in the blowpipe about half-way along, taking care not to leave a fine end, and also not to allow any water vapour from the flame to find its way in. The fine end is then cooled by means of alcohol; and when we cannot observe any depositon of water there, we gently heat the other end, where the mineral is, up to dull redness.

Generally the water collects at the shoulder where the tube is drawn off, without it being necessary to cool it. By bringing the flame further along we can concentrate all the water in the capillary end.

To prove the presence of very small quantities of water we can still have recourse to a reaction which is based on the colouration of fuchsine under the influence of water. It is obvious that to effect this the tubes must be prepared beforehand.

An alcoholic solution of fuchsine leaves, by evaporation on a glass plate, a slight opaque film, of a yellowish green colour and a metallic lustre. If we introduce a narrow band or some particles of this substance into the capillary part of the tube, and if we then drive the deposit of condensed water towards the spot where the fuchsine is, we observe that the latter loses its metallic lustre and takes a transparent red colour.

(To be continued).

AN APPARATUS FOR MAINTAINING CONSTANT TEMPERATURES UP TO 600°.*

By G. H. BAILEY, D.Sc., Ph.D.,
Assistant Lecturer on Chemistry, The Owens College.

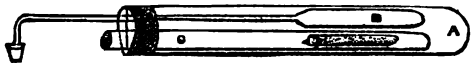
Several months ago this apparatus was described before the Chemical Society.. It consists essentially of a furnace (not shown in the figure) of six Bunsen burners, a heating tube, an air thermometer (so arranged that the temperature may at any time be estimated), and a regulator by which the temperature may be limited and kept constant. These parts will be described in the order given.

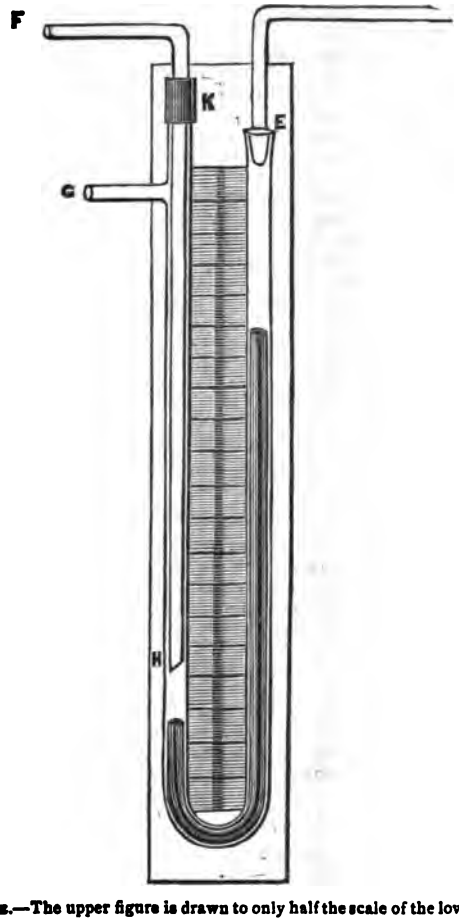
The heating tube (A) is of combustion glass, closed at one end; it is 25 c.m. long and 4 c.m. in diameter, and is placed horizontally within an iron casing over the furnace. Within this is the heating tube proper (C), into which the substance to be heated is introduced in a platinum boat (D), whilst alongside this tube is the bulb (B) of the air thermometer.

In order that the temperature, as indicated by the air thermometer, may as nearly as possible correspond with that of the substance heated, the inner tube and air thermometer are arranged along the horizontal diameter of the outer tube, and this latter is separated from the iron casing by an air space. In point of fact it is found that the variations of temperature do not exceed 2 or 3 degrees. The bulb of the thermometer is connected, by means of a capillary tube, with a U-tube (E), the near limb of which is in the first instance filled with mercury, whilst the further limb contains a column of 3 or 4 c.m. As the heating proceeds the column of mercury in the near limb of the U-tube is depressed, the amount of the depression being a measure of the temperature; indeed the instrument may be graduated by noting the temperature on a high-boiling thermometer placed in the heating

* A Paper read before the British Association, Birmingham Meeting, Section B.

tube, and the reading of the mercury column on the millimetre scale attached to the U-tube. The further limb of the U-tube answers as regulator, and by it we are enabled to limit the temperature to any desired degree. This is done by causing the gas supply for the furnace to pass through the tube (F, H) and out at the side tube (G). At H the tube is cut off slantwise, and perforated with a small hole a little above the outlet, as in an ordinary gas-regulator. As, then, the column of mercury is depressed in the near limb of the U-tube, it rises in the further limb, ultimately reaching the outlet (H) and partially cutting off the gas supply; it is evident, therefore, that if the





Note.—The upper figure is drawn to only half the scale of the lower.

outlet of the regulator is only a short distance above the mercury, this point is soon reached, and a low limit of temperature (say 100°) is attained. The temperature can be kept at this point for any period desired; then by raising the regulator somewhat (and this is easily done, since it slides in the indiarubber connection, K) a higher limit (say 120°) can be attained, and so on up to 600°, beyond which no trial of the apparatus has been made.

In order to prove that the apparatus is reliable the author has determined a number of melting-points with it; he has also calculated the temperatures from the known volume of the air-thermometer bulb, according to the law of expansion of gases.

An attempt to control the higher temperatures by Siemens's electrical method, though it showed general agreement, cannot be said to have confirmed the observations with any definiteness, since in this method so much depends on the particular character of the platinum used.

The immediate purpose for which the apparatus was designed is the determination of the atomic weight of those elements in which it is necessary to employ the normal sulphate, and the author is of opinion that by the use of such means the determination from the sulphate may attain a much higher degree of accuracy than heretofore. The normal sulphate will be heated at successive temperatures until decomposition begins to set in, this point being indicated by aspirating a current of air through the heating tube after each period, and passing it through a solution of barium chloride. Having determined the lowest temperature at which decomposition occurs, the sulphate is then heated with excess of sulphuric acid, and that point determined at which it loses all free sulphuric acid; and these temperatures having been ascertained once for all, it is only necessary in further experiments to heat the sulphate (with excess of sulphuric acid) at some temperature lying between these limits until constant.

As the process can be watched and the products of decomposition collected and examined, it is hoped that the apparatus may prove useful in examining the general phenomena of decomposition of salts by heat.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 292.)

Dr. Gascoyne then read the following experiments designed to compare the official method for determining total phosphoric acid by ignition with magnesium nitrate with that of dissolving in nitric acid without previous ignition:—

Samples of commercial fertilisers containing large percentages of organic matter derived from fish scraps, tankage, azolin, &c., were used in the experiments.

In the nitric acid method 2 grms. of the fertiliser were dissolved in 50 c.c. nitric acid and a few drops of hydrochloric acid, the solution made up to 1 litre, and an aliquot taken representing ½ grm. of the material.

	Official method.	Nitric acid method.
No. 1, commercial fertiliser	11·64	11·66
No. 2, commercial fertiliser	10·15	10·12
No. 3, commercial fertiliser	12·01	12·08
No. 4, commercial fertiliser	11·05	11·01
No. 5, commercial fertiliser	12·86	12·77
No. 6, commercial fertiliser	11·90	11·93
No. 7, tankage	13·65	13·68
No. 8. bone meal	23·27	23·26
No. 9, fish scrap	7·17	7·22
No. 10, tankage	9·19	9·16

It will be seen that the nitric acid method is quite as satisfactory as the official.

The Secretary then read, by consent of the Association, a paper contributed by Dr. William Frear and H. B. McDonnell, of the State College of Pennsylvania, entitled:—

A Comparison of Wagner's and the present Association Methods for the Determination of Available Phosphoric Acid.

Some time ago the fertiliser control stations of Southern Germany adopted for their official method for the deter-

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

Designation.	Association Method. Total P_2O_5.	Soluble.	Insoluble.	Reverted.	Available.	Wagner's Method Soluble. a.	b.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Fine ground South Carolina rock	27·11	0·00	25·85	1·26	1·26	1·56	1·37
2. Fine ground apatite	39·44	0·00	38·59	0·85	0·85	0·66	0·63
3. Fine ground bone	24·06	0·16	19·33	4·57	4·73	5·19	5·28
4. Dissolved South Carolina rock ..	17·19	10·04	3·50	3·65	13·69	11·56	11·49
5. Dissolved bone-black	16·02	12·32	0·66	3·04	15·36	15·24	14·80
6. Dicalcium phosphate	43·76	3·77	11·85	28·14	31·91	23·67	23·44
7. Dissolved bone-ash	21·87	14·29	3·61	3·72	18·01	14·39	14·74
8. Raw Navassa	28·83	0·00	27·80	1·03	1·03	2·42	2·51
9. Orchilla guana	18·11	0·00	14·43	3·69	3·69	3·25	3·27

mination of available phosphoric acid, that employing an acid solution of citrate of ammonium, as proposed by Prof. P. Wagner. This method, together with an abstract of the results obtained by Wagner in the treatment of various phosphates, was presented by Dr. Shepherd in a late number of the *American Chemical Journal*, to which I will refer for the details of the method.

At my suggestion a comparison of this method with that at present approved by the Association of Official Agricultural Chemists was made by Mr. H. B. McDonnell in the laboratory of the Pennsylvania State College.

The results of his analyses of various phosphatic substances are presented in the appended table.

In determining Wagner's "soluble" acid (corresponding to our "available") duplicates of samples 1*a* to 6*a* were taken from different flasks, which stood about twenty hours over night, and were frequently shaken during the afternoon and morning. Samples 1*b* to 6*b* were treated similarly, but stood only six hours. The duplicates of 7*a* to 9*a* were taken from the same flasks and stood fourteen hours; 7*b* to 9*b* stood sixteen hours.

Owing to the pressure of other work, I am unable to do more than note the facts most clearly shown by the data.

Accepting the means of the results of 1*a* to 6*a* and 7*b* to 9*b* as those best representing Wagner's method, a comparison with the "available" acid obtained by the Association method shows that the former method gives somewhat higher results with fine ground South Carolina rock and fine ground bone, and more than doubles the amount in raw Navassa rock. On the other hand, it gives somewhat lower results with fine ground apatite, dissolved bone-black, and Orchilla guano, and several per cent less with dissolved South Carolina rock, dissolved bone-ash, and dicalcium phosphate.

A comparison of the results in columns *a* and *b* to determine the limits of time in which the solution is completed, taking first samples 1*a* to 6*a*, shows that sixteen hours suffices to practically complete the solution of the available acid in fine ground apatite, fine ground bone, and dissolved South Carolina rock; and that there is a gain of 0·1 to 0·4 per cent by standing twenty hours in the other cases. In samples 7 to 9 the results with Orchilla guano are not materially aided by an increase of two hours over the original fourteen hours allowed for solution, but in the other cases the gain is considerable.

The President then announced the subject as open to discussion.

Mr. Chazal remarked upon the uncertainty of determining specific gravity by means of the densimeter, except when great care is used in correcting the instrument, and hoped the determination by weight would be recommended.

Professors Mosrs and Lupton thought that the densimeter should be retained as a matter of convenience, but that careful correction should be made upon the instruments used.

Dr. Jenkins called attention to the fact that new thermometers of approved make are occasionally incorrectly graduated, and a thermometer, correct, when new, will, on use, change its zero point very considerably, so that frequent examination is necessary to secure exactness as to temperature, both in the preparation of ammonium citrate and in the extraction of citrate-soluble P_2O_5.

Prof. John A. Myers remarked that it is possible that much of the variation in the results of analysis may, no doubt, be accounted for by the fact that weights and other instruments used in the processes of analysis are subject to wide variations. Out of eight sets of weights in his laboratory bought for standard sets but three sets could be found that would compare sufficiently closely not to seriously affect the results of the work. Whether this trouble extends to other laboratories in the country he had no means of ascertaining.

The possible effects in the variation in the thermometers, and also in apparatus for determining specific gravity, may be seen in the difficulty of getting concordant results in our insoluble phosphate determinations, thus affecting the citrate of ammonium solution appreciably.

The opinion was finally elicited that members should use the methods which they preferred, but that great care should be used to insure accuracy.

Mr. Chazal then called attention to the loss occasioned when, in washing out soluble phosphoric acid, the fertiliser is washed from the funnel into a mortar and returned to the filter; also to the disadvantage of shredding filter-paper into citrate solution, causing danger of imperfect washing out with water, and also retarding contact of fertiliser with the citrate solution when shaken.

He also brought up the question of the use of magnesic nitrate, and showed the possibility of the retention of phosphoric acid in the hard white cake formed on ignition.

Dr. White then read some notes of experiments on the use of $Mg(NO_3)_2$ in ignition.

On the Use of Magnesium Nitrate.

The following experiments were made to determine if ignition with $Mg(NO_3)_2$, in order to destroy organic matter, could be replaced by wet methods:—

(1) A commercial fertiliser containing acid phosphate, potash salts, and animal matter, was selected; total P_2O_5 was determined.

(*a*) By digesting 0·5 grm. for thirty minutes with 30 c.c. concentrated HCl.

(*b*) By digesting 0·5 grm. for thirty minutes with 30 c.c. concentrated HCl, adding at intervals pinches of finely-powdered $KClO_3$ (0·5 grm. in all).

(*c*) By digesting 0·5 grm. for thirty minutes with 30 c.c. fuming HNO_3.

(*d*) By igniting 0·5 grm. with $Mg(NO_3)_2$ in usual manner.

Results were as follows:—

	a.	*b.*	*c.*	*d.*
Total P_2O_5..	11·68	11·95	11·82	12·05
	11·73	11·98	11·80	11·93
Mean	11·70	11·97	11·81	11·99

(2) A commercial fertiliser containing acid phosphate, potash salts, and cotton seed meal was selected. Methods detailed above were employed. Results were as follows:—

	a.	*b.*	*c.*	*d.*
Total P_2O_5..	10·12	10·52	10·36	10·47
	10·28	10·54	10·32	10·47
Mean	10·20	10·53	10·34	10·47

The results showed that the use of $KClO_3$ with HCl was much the best method of working, both in convenience and results.

The general testimony which followed was in favour of oxidation of the organic matter in other ways than by means of $Mg(NO_3)_2$.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

December 11th, 1886.

Prof. H. McLeod, F.R.S., Vice-President, in the Chair.

W. Natanson, E. Natanson, the Hon. R. Abercromby, Jul. Verteimer, and H. M. Elder were elected Members of the Society.

The following papers were then read:—

"*On the Influence of Change of Condition from the Liquid to the Solid State on Vapour Pressure.*" By Prof. W. Ramsay, Ph.D., and Sydney Young, D.Sc.; read by Dr. Young.

The authors refer to some experiments published in Wiedemann's *Annalen* (vol. xxviii., p. 400), by W. Fischer, on the above subject, which show that the vapour pressure of ice and solid benzene are less than those of water and liquid benzene at the same temperatures. By using the formula $p = a + bt + ct^2$ to express the relation between the pressure and temperature of saturated vapours, Fischer arrives at the absurd result that the vapour pressure of liquid benzene is not identical with that of solid benzene at its melting-point. If the above formula be replaced by $\log p = a + b\,a^t$, it is shown that the anomaly disappears. The authors have measured the vapour pressures of solid and liquid benzene by the dynamical method, and obtain results agreeing closely with those of Fischer determined statically. They also calculate the vapour pressure of solid benzene from that of the liquid, using the formula—

$$P_{t-1} = P_t - (P'_t - P_{t-1})\left(\frac{V_{t-\frac{1}{2}} + F_{t-\frac{1}{2}}}{V_{t-\frac{1}{2}}}\right),$$

where P_t and P'_t are the vapour pressures of the solid and liquid at temperature t, $V_{t-\frac{1}{2}}$ = heat of vaporisation of liquid, and $F_{t-\frac{1}{2}}$ = heat of fusion of solid at temperature $t-\frac{1}{2}$. The numbers so obtained are in accordance with those determined experimentally.

"*On the Nature of Liquids as shown by the Thermal Properties of Stable and Dissociable Bodies.*" By the same Authors; read by Prof. Ramsay.

From experiments on the vapour density and heat of vaporisation of stable and dissociable bodies the authors arrive at two important results:—(1.) That for stable bodies such as alcohol and ether the density of their saturated vapours increases with rise of temperature, whereas for bodies such as acetic acid and nitric peroxide the vapour density attains a minimum at a certain temperature and increases with either rise or fall of temperature. (2.) The heat of vaporisation of alcohol decreases with rise of temperature, but that of acetic acid attains a maximum at about 110° C. and decreases with rise or fall of temperature. From these results the authors seek to prove that the difference between stable liquids and their vapours consists in the relative proximity of the molecules, this proximity being greater in liquids than gases, and that the molecules of stable liquids are not more complex than those of their gases.

Prof. Pickering dissented from this view, and thought that the molecules of liquids are aggregations or compounds of those of the gases.

In answer to enquiries by the authors, Mr. Lewis Wright said bodies which rotate the plane of polarisation of light when in the liquid state also rotate it in a proportionate degree when gaseous; and Captain Abney remarked that stable liquids and their vapours give similar absorption spectra, whereas those of dissociable bodies differ considerably. Both these facts seem to support the view put forward by the authors.

An Account of Cauchy's Theory of Reflection and Refraction of Light. by James Walker, M.A.

This paper is intended as a statement of the work previously done in the subject, and gives references to the original papers and "reproductions," &c., which will be of great value to persons studying this important branch of the theory of Optics.

Mr. Shelford Bidwell exhibited and described a voltaic cell in which the electrolyte is dry peroxide of lead. It consists of carefully dried peroxide placed between plates of lead and sodium, and gives a comparatively strong current, which passes from the sodium to the lead within the cell.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 2nd, 1886.

Professor Osborne Reynolds, LL.D., F.R.S., Vice-President, in the Chair.

"*The Action of Hydrochloric Acid Gas upon certain Metals,*" by J. B. Cohen, Ph.D., F.C.S. Communicated by Dr. A. Schuster, F.R.S.

From certain considerations I was led to believe that hydrochloric acid gas, freed from all traces of water, would not act upon certain of the metals. This idea was further supported by the observations of Gore with liquefied hydrochloric acid (*Proc. Roy. Soc.*, xiv., p. 204), who found that zinc, iron, &c., were scarcely acted upon, and that out of fifteen metals, only one, viz., aluminium, was dissolved by the pure liquefied acid.

Preparation of Dry Hydrochloric Acid Gas.—The gas was prepared by the action of ordinary concentrated sulphuric acid, previously well boiled, upon lumps of fused sodium chloride. The gas passed through two wash-bottles containing concentrated sulphuric acid (previously boiled), then through a series of eleven bulbs blown on one stem, and placed at an angle of about 45 degrees, also containing concentrated sulphuric acid; and, finally through a tube about twenty-six inches long and one inch wide, well packed with phosphoric anhydride. The evolution flask was connected by a T piece, with the drying apparatus on the one hand and with a tube dipping under dry mercury on the other, the latter serving as a safety valve. All the joints were well secured with thick india-rubber tubbing, wrapped round with copper wire, and then thickly coated with melted paraffin.

The first metal experimented upon was metallic sodium.

Preparation of Metallic Sodium.—The following method was found to give the best results in preparing clean metallic sodium. It is one, however, which requires the exercise of patience, because often as many as a dozen of the tubes employed break before a successful operation is achieved. A clean glass tube, about 1½ feet long and ¾ inch diameter, is drawn out at one end into a pear-shaped bulb. This is placed vertically in a clamp with the pear-shaped bulb downwards. This may be called the bulb end. Through the bulb end a current of coal-gas is passed until most of the air is displaced. A plug of glass-wool is meanwhile introduced through the upper end so as to fall over the constricted part of the tube, and above this pieces of clean dry sodium are placed so as to fill about one-half of the upper portion of the tube. The tube is

coal-gas delivery tube. The cylindrical part is now sealed. There still remains in the tube a considerable quantity of air. To absorb this, the sodium is melted at a gentle heat over the flame, allowed to cool, and the operation performed repeatedly for two or three days, the tube being held in a horizontal position. The sodium is now filtered through the glass-wool into the pear-shaped bulb. This is done as follows:—The sodium is first melted and the tube tilted with the bulb end downwards. On heating the bulb, bubbles of gas are driven through the melted sodium, and on cooling, the tube being still held vertically, the sodium passes slowly into the bulb through the glass-wool, which retains the unmelted oxide. This process of filtration may be hastened by warming at the same time the upper part of the tube. If sufficient time has been allowed, and the re-melting of the sodium often enough repeated, the metal runs through and has a bright metallic surface. Out of a large number of tubes prepared in this way only two were successful. The glass easily cracks on warming the metal when firmly adhering to the walls. The pear-shaped bulb is now sealed off and the sealed ends doubled round in the form of hooks. The bulb is placed in one compartment of a tube drawn out in the middle; the other compartment is filled with phosphoric anhydride and separated by a plug of glass-wool. This tube is connected with the hydrochloric acid apparatus, the compartment containing the bulb being attached to the phosphoric acid tube of the hydrochloric acid apparatus. The other end is connected with a wash-bottle of concentrated sulphuric acid. All the joints having been carefully secured, hydrochloric acid gas is slowly bubbled through the apparatus for several hours (both before and after attaching the sodium tube) until a sample of gas issuing from the last wash-bottle is entirely absorbed in water. The tube containing the sodium is also heated gently whilst the gas is passing through to drive off traces of moisture possibly adhering to the sides. The sodium tube is now sealed off at both ends, and the bulb broken by allowing the hooked ends to fall sharply against the end of the tube. The following results were then noted in two experiments:—

1. The sodium retained its metallic appearance for a few weeks, and it slowly assumed a dark grey colour, finally, after several months, a deeper violet grey.

2. The sodium lost its metallic appearance much more quickly, and after a few weeks became dull black, like charcoal. This blackness did not extend far below the surface, that portion of the metal attached to the glass retained its mirror-like appearance.

The composition of this black compound has not been further investigated; but it may possibly be a sub-chloride of sodium.

Experiments with metallic aluminium point to the fact that it is unacted upon by the gas when dry, whereas, as is well known, it is readily tarnished by moist hydrochloric acid gas, and dissolves in the liquefied acid.

These experiments, which have for the present been discontinued owing to want of time, will be taken up again, and a large number of facts, if possible, collected.

"*Capillary Constants of Benzene and its Homologues occurring in Coal-Tar*," by J. B. COHEN, Ph.D., F.C.S. Communicated by Dr. A. SCHUSTER, F.R.S.

The object of the present paper is to bring before you a subject which promises to have special interest to the chemist, viz., capillarity as a property on which a method of analysis may be based. Capillary constants of liquids, and their relation to chemical composition and constitution, have been recently carefully studied by Schiff, who determined these constants at the boiling temperatures of the liquids. More recently, Traube has investigated the constants of substances in solution, a practical outcome of which has been a method for determining the percentage of fusel oil in spirits and wines. This method is fully given in the *Berlin Berichte*, method, and simplify it, if possible, for practical purposes of rapid analysis, I undertook the determination of the capillary constants of benzene and those homologues of benzene which occur in coal-tar. The reason for attacking this special line was simply because, as those who are acquainted with the coal-tar industry know, the methods at present in use for determining the percentage constituents of benzene and its homologues occurring in commercial coal-tar naphthæ are rough methods, and lack accuracy; and there is, especially, no quick method for determining the presence and estimating quantitatively carbon-bisulphide, paraffin, or petroleum, which are often found in the commercial products. In these determinations I must admit, at the outset, that no very great success has attended them; at the same time, the value of the method should not be overlooked; and, as to the results, I have very little doubt that those who care to pursue the subject will hit upon something which will turn out more useful and successful—for example, in the analysis of mixtures of oils. To fulfil the conditions of a practical analytical method, the apparatus must be of simple construction, easily manipulated, and the determination rapidly performed, consistent, of course, with accuracy. For comparative determinations, the apparatus to be described will be found to answer well. Instead of using a capillary with a movable and adjustable scale employed by Traube, I find that a piece of thick thermometer tubing, with a fine round capillary, 0·155 m.m. bore and about 26 c.m. long, which was supplied to me by Mr. L. Casella, of London, served my purpose excellently. Along its whole length it was etched in millimetres. By a very simple arrangement of a mirror, usually used in such determinations, it is a matter of little practice only to be able to read off the scale to tenths of a millimetre with a pocket magnifying glass.

The first point to be determined before employing this tube was, whether a piece of thermometer tubing, 0·155 m.m. bore, could be thoroughly cleaned and dried without deteriorating with use. The tube was thoroughly cleaned with ether or alcohol after each determination, by plunging it half way in pure dry ether, so that the ether rose at least two-thirds of the distance up the capillary. By bringing the lower end on to a piece of clean silk cloth, the capillary was rapidly emptied, and this process repeated three or four times, and finally dried by the following arrangement:—The thermometer tube is placed in an outer tube of glass, closed at one end and constricted in two places. At the open end of the outer tube a plug of cotton-wool is inserted round the thermometer tube, which serves to filter the air passing into it. The thermometer tube is attached by a piece of india-rubber tubing to a narrow glass tube containing cotton-wool; and by a longer piece of india-rubber to a calcium chloride tube, which may be closed by the pinch-cock and india-rubber tube. The glass tube, which is perfectly cleaned before use, is plugged with cotton-wool when not required. In order to dry the capillary, the apparatus is fitted up as described, and the outer tube heated. By partly exhausting the air at the pinch-cock end, which is then tightly closed, a partial vacuum is produced, and with my tube the pressure equalised itself after about six minutes, during which time a constant stream of hot air was passing through the capillary. With such an arrangement, and by always taking the precaution to cover the thermometer tube, whilst in use, with an open glass cap containing cotton-wool, I found that a tube of this kind might be employed for an almost unlimited number of determinations. These determinations were made in the following manner:—The liquid was placed in a small bottle; the thermometer tube, after being sunk into the liquid and adjusted perpendicularly by a plumb-line, was left for a short time. The height to which the liquid had risen was read off on the scale in millimetres with a magnifying glass, and the reading below the meniscus also taken. The

difference gives the height in millimetres which the liquid has risen in the capillary. The tube is now raised a few millimetres, and the height again read off; the process repeated once or twice and the mean height taken. With pure benzene, the following gives the height in millimetres of the column of liquid, determined at different times in the course of the present investigations :—

	Height in millimetres.	Temp.
1.	83·65	15°
2.	83·4	15°
3.	83·05	16°
4.	83·05	16°

As is well known, in such determinations the temperature is a very important factor. As in the case just given, 1° C. corresponds to a difference of about 0·05 c.m. I therefore carefully noted the temperature of the room at the beginning of each reading, and took care to leave all the vessels and liquids there several hours before use. During the whole time the temperature remained between 15° and 16°. No precaution against evaporation was taken nor required, except in the case of mixtures, when a plug of cotton-wool was inserted in the neck of the bottle. The mixtures were made by running in from a burette a certain number of drops of the different liquids.

	Boiling-point.	Height in m.m.	Temp.
Benzene	80—80½	83·65 83·05	15° 16
Toluene	109·7—110·05	83·95 83·2	15 16
Orthoxylene ..	143·8	86·95	15½
Paraxylene ..	137·6—138·8	83·80	15½
Metaxylene ..	138·2—138·7	84·3	16
Pseudocumene..	167—169	86·1	16
Mesitylene ..	160—161	84·75	16
Alcohol (absolute)		71·5	—
200 drops benzene		82·5	16
2 „ alcohol			
Carbon bisulphide		64·9	15
200 drops benzene		82·7	15
5 „ CS_2			
200 drops benzene		81·45	15
10 „ CS_2			
Petroleum	79—81	71·8	15
300 drops benzene		82·45	15
10 „ petroleum..			
300 drops benzene		83·1	15
6 „ petroleum..			

It appears from the above that in the case of the pure hydrocarbons the difference is too small to be able to base upon it any reliable method of analysis. In case, however, of small quantities of impurities, which are often found in commercial benzene, the height of the column is sufficiently depressed to be able to detect the presence of small quantities of carbon bisulphide or petroleum.

NOTICES OF BOOKS.

Outlines of Quantitative Analysis. By A. Humboldt Sexton, Professor of Chemistry in the College of Science and Arts, Glasgow. London: Charles Griffin and Co.

The author, in his Preface, points to a very important object at which his book is aiming. "To the practical man it [*i. e.*, the study of actual quantitative work] is also of great value; not that it will enable him to dispense with the services of the professional chemist, but—and this is more important—it will enable him to understand the meaning and the value of analytical results,—a knowledge which is unfortunately not very common among practical men." Too true: the consulting chemist is sometimes expected to effect things absolutely self-contradictory,—*e. g.*, to increase the percentage of one ingredient in a compound without diminishing that of the others.

Mr. Sexton gives one method only for each determination,—a limitation perfectly justifiable in a book of such limited extent.

After a preliminary account of the balance he gives a chapter of introductory exercises, such as determinations of moisture, of ash, of solid matter in solutions, of the specific gravity of liquids, and of insoluble matter in salts. He then proceeds to simple gravimetric analyses, one substance only being determined in each case.

Then follow exercises in volumetric analysis, beginning with alkalimetry and acidimetry. Here we notice that litmus is the only indicator recommended.

In the chapter on determinations with previous separation, the method given for separating alumina from iron is the alkaline hydrate process, whilst for separating cobalt and nickel the author uses the potassium nitrite.

Then follow miscellaneous examples, varying much in their difficulty, and consequently in the degree of skill and care which they require.

Lastly, we find instructions for ultimate organic analysis and Appendix of Tables.

The various processes are carefully described, and the student is warned against possible sources of error.

Organic Colouring-Matters (Organische Farbstoffe). By Dr. R. Nietzki. Breslau: Eduard Trewendt.

This work is a separate re-publication from the chemical department of the "Encyklopædia der Natur Wissenschaften," now being issued by the above-named publisher.

In his very interesting Introduction the author contends that the compounds formed by organic fibres with colouring-matters are compounds analogous to salts, in which the fibre plays the part sometimes of an acid and sometimes of a base. Thus if we introduce woollen or silk into the colourless solution of the rosaniline, the fibre is dyed intensely red, just as if a corresponding quantity of a salt of rosaniline had been present. To explain this phenomenon, the author considers that the colourless base forms with the fibre a compound which behaves like a salt of rosaniline. Hence in this compound the fibre plays the part of an acid. "Salts of colour bases are probably decomposed by the process of dyeing,—at least this assumption explains the fact that certain very strongly basic colours, in the form of salts, do not take upon wool. Such a colouring-matter is, for instance, methyl-green. Its salts, like all those of the ammonium bases, are very stable, and woollen yarn introduced cannot decompose them, and hence it remains not dyed. The dyeing, however, takes place if the bath is rendered slightly alkaline by the introduction of ammonia. The silk fibre seems to have more decidedly acid properties than that of wool, and it is therefore dyed also by colours of the kind just mentioned. Corresponding phenomena are encountered in dyeing with acid colouring-matters. The animal fibre is generally unable to decompose the salts of tinctorial acids, and the latter must be set at liberty by the addition of other acids."

This would explain why the woollen-dyer finds an addition of sulphuric acid to his dye-pans so often necessary.

The author fully admits the difficulty of explaining, from a chemical point of view, the exceptional affinity of curcumine and carthamine for vegetable fibres. His views, however, widely as they differ from the prevalent theory of the process of dyeing, seem to us to merit a careful experimental investigation.

Dr. Nietzki divides the organic colouring-matters into two great classes, the natural and the artificial. From the former he excludes, however, alizarine and indigo. In

regards indigo we must demur. Very lately Dr. O. Witt, who, as a German, would naturally sympathise with the attempt to produce indigo-blue in German manufactories instead of in Indo-British plantations, frankly pronounced artificial indigo a chemical curiosity, and owned that, as far as practical purposes were concerned, the plant must retain its supremacy.

Among the natural dyes we find no mention of the colouring-matter of bar- and cam-woods, though santaline —the colouring-matter of santal-wood—is duly described.

Flavine is not mentioned under quercitron-bark, nor do we find any notice of fustine, the colouring-matter of the so-called young fustic.

Orchil is much more commonly used as a paste than as a powder.

Xylindeine is a very curious green colouring-matter, which might be of practical value if it were more abundant. It is found sometimes in the decaying wood of the beech, oak, and birch.

Berberine receives notice as the only natural colouring-matter of a basic character. It behaves with the fibre like the artificial basic dyes, and is fixed upon cotton by means of tannin.

In speaking of carmine the author seems not to accept certain recent investigations, which show that this pigment contains not merely alumina, but lime, in such a state of combination as to be soluble in ammonia.

The classification of the coal-tar colours is admitted to be a task of no small difficulty. The arrangement which he adopts is as follows:—Nitro-compounds; azo-dyes; triphenylmethan dyes: indamines and indophenols; safranines and their allies; aniline black; indulines and nigrosines; chinoline and acridine colouring-matters, and anthraquinone dyes. The number of compounds mentioned under these heads is very great, though a large part of them do not admit of any practical applications in the tinctorial arts.

Under each section there is a fairly complete bibliography of the subject.

Typographical errors in proper names have not in all cases been avoided. Thus the firm "Williams, Thomas, and Dower" is rendered William Thomas in (*anglicé* of) Dower, as if Dower were the name of some place where the above firm carried on their business.

Under "Aniline Black" we find no mention of a name which has of late become a household word among French and Belgian dyers in connection with patent litigation.

The account of Turkey-reds might be misunderstood to imply that the so-called alizarine oil (produced by the action of sulphuric acid upon castor oil) has superseded the emulsive olive oils, known in France as *huile tournante*.

This work compresses a wonderful quantity of information into the brief compass of 160 pages, and will prove a useful addition to the library of the colour chemist. A good index, however, would greatly enhance its value.

Notes on the Literature of Explosives. No. IX. By Prof. CHARLES E. MUNROE, U.S.N.A. (Reprinted from No. 35 of the *Proceeding of U.S. Naval Institute*).

THE author first gives a short account of the blowing up of the Flood Rock, which was successfully accomplished on the 10th October, 1885. The rock consisted of hornblende gneiss with intersecting cross veins, and it was thoroughly honeycombed with tunnels until they amounted to about 4 miles in total length. 80,000 cubic feet of rock having been removed, the walls and ceilings of these tunnels were then drilled with holes, and upwards of two hundred and eighty-eight thousand pounds of rackarock and dynamite cartridges placed therein; the explosion, which was effected by electrical means, lasted about thirty seconds. The rate of transmission of the terrestrial and aërial shocks was observed, but has not yet been reduced. Uses in War," in which the question of using dynamite and gun-cotton in shells is discussed; such shells do not appear to be so destructive to a body of men as similar shells charged with gunpowder would be, because the action of dynamite, &c., when exploded, is intensely local; the object which artillerists are endeavouring to accomplish is the destruction of armour plates by embedding a shell in the plate first, and then causing the explosion by means of a time fuse; but the difficulty appears to be in getting a moderate sized shell to carry a sufficient charge. The author then goes on to consider whether it would not be better to send a projectile with a much greater velocity and a less charge, but he concludes that this cannot be satisfactorily determined without experiments.

In some experiments for rendering the lighter petroleum oils inexplosive, the author found that if camphor were dissolved in kerosene, the flashing-point was raised 12°, but that, on the other hand, the vapour of this camphorated kerosene, when mixed with air, exploded with greater readiness than the original kerosene.

A note from the *Times* gives a description of a new explosive called hellhoffite, a solution of a nitrated organic compound such as naphthalene, phenol, or benzene, in fuming nitric acid. In the trials of this against other explosives, the charge of about 20 grms. was placed in a glass bottle, on the top of a truncated cone of lead 6 c.m. high and 4 c.m. diameter at the middle. The explosion of gunpowder caused no change; that of nitroglycerin compressed the cone about one quarter of its weight; while that of hellhoffite almost destroyed the cone, more than half of it being torn away, while the rest was very much defaced. Hellhoffite cannot be exploded by a lighted match or by concussion, both of which are great advantages.

A curious explosion is recorded in the Boston *Journal* of June 30, 1885. A gentleman had some chlorate of potash lozenges in his pocket, and, on returning his watch to his pocket one day, he was much startled and slightly burnt by the lozenges exploding; this explosion was evidently caused by concussion, and manufacturers are warned to avoid trituration and pressure when making these tablets.

Mr. Munroe, proposes to continue the publication of these most interesting Notes from time to time, and he invites authors, publishers, and manufacturers to send him copies of their papers and circulars, so that his notes may be as complete as possible.

Proceedings of the Illinois Pharmaceutical Assocation at its Seventh Annual Meeting, held at Rockford. Edited by ALBERT E. EBERT. Chicago, 1886.

THE first sitting was on Tuesday afternoon, June 8th, and after the Society had been welcomed by the Mayor of Rockford the President delivered his Address, in which, after reviewing the work of the Association for the past eight months, he condemned patent medicines as "the most gigantic fraud and worst evil scientific pharmacy has to deal with at the present time," and held out hopes that before long the Pharmacy Law would be modified so that the sale of these nostrums could be controlled.

The sale of patent medicines in America is carried on to a much greater extent than it is in England, although it has been increasing considerably with us during the past few years; but we do not see what steps could be taken to prevent the sale of any preparation that is not actually poisonous.

At the following meetings the Reports of several Committees were read and discussed.

In the latter part of this Report we find the answers which have been sent to queries set at the previous meeting. These queries are thirty in number. The first is as follows:—What drugs and preparations are prescribed by physicians in Illinois? Twenty-two answers

were received, each giving a thousand prescriptions, and they have been tabulated by the Secretary, Mr. L. Hogan, who finds that the number of substances required for the treatment of disease is being constantly augmented, and he concludes that we are either progressing very fast, or else there is a great deal of experimenting going on. The other questions cover a good deal of ground and seem to be very useful, inasmuch as the opinions of the different members can in this manner be learnt by all, much better than by discussion at the meeting.

CORRESPONDENCE.

THE TEACHING OF SCIENCE IN SCHOOLS.

To the Editor of the Chemical News.

SIR,—I was greatly struck with the quotation from Sir James Paget's speech (CHEMICAL NEWS, vol. liv., p. 296). Of many causes which render Science Teaching in Schools futile the following are well known :—

1. The head-master of most important schools are classical men.
2. Laymen, though sometimes fairly well qualified to teach Science, are thought good enough for most schools.
3. Head-masters frequently expect Science-masters to teach other branches, as (say) Mathematics, English, &c.
4. No time is given for preparation of class experiments, or the many necessary duties falling upon those who even have to teach but Elementary Science.
5. In most cases anything approaching research is out out of the question.
6. Head-masters, many of whom are uniquely ignorant of the merest rudiments of Science, imagine that a man can go into a lecture-room and give a lesson—say in Chemistry—as one would take a class in Latin.
7. In fitted Laboratories want of space, time, and necessary appliances preclude the teaching of *real* Science, added to which fact the many examinations encourage what Prof. Armstrong calls "test-tubing" (as far as Chemistry is concerned).
8. The marks for Science Subjects, in examinations for public appointments, are very unfairly allotted, causing head-masters and parents to look askance at such subjects as Chemistry, Geology, &c.
9. In many cases the most intelligent pupils never have time for good Science work, so great is the importance attached to literary subjects, whereas the dullard and ne'er-do-well is relegated to the "Lab." just to amuse himself.

I hope the subject started in your paper may be opened up by men far better qualified to write than myself.—I am, &c.,

J. H. B.

AN EXAMINATION PUZZLE.

To the Editor of the Chemical News.

SIR,—May I beg for space to point out that your correspondent A. P. S. (CHEMICAL NEWS, vol. liv., p. 297) has left unexplained the most serious part of the misconduct of x (p. 273), which was charged with giving no precipitate with *platinum chloride* after filtration from a precipitate produced by *ammonia*.

Sodium aluminate, containing two metals, is excluded by the limits of the examination, and the question implies that ammonia is added directly to the alkaline liquid.

Sodium silicate is described in books as *soluble in water*, and in a sense it is so; but let A. P. S. buy some, and tell us how long it takes him to dissolve it. I have recently done so, and have digested it for some weeks in water with only partial solution.

A candidate should hardly be expected to answer questions which do not accord with ordinary laboratory experience.—I am, &c.,

A. X.

December 11, 1886.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 22, November 29, 1886.

Contribution to the History of the Decomposition of Amides by Water and Dilute Acids.—MM. Berthelot and André.—The authors maintain that the decomposition of ammonical salts by water must be taken into account in the analytical study of complex organic matters capable of yielding small quantities of ammonia when distilled with water. The action of acids varies in intensity according to the nature of the amide. It is almost instantaneous with potassium cyanate, slower, but well marked, with urea, and still noteworthy with asparagine and oxamide. The action increases with temperature and concentration. On operating, not with amides derived directly from ammoniacal salts, but with amine-alcohols, the results are of a different nature. The splitting up of complex amides often reproduces, at first amines sparingly, or not at all volatile, which cannot be determined by distillation with magnesia.

Fluorescences of Manganese and Bismuth.—Lecoq de Boisbaudran.—The author describes the fluorescence produced by manganese and bismuth, added to salts of calcium, magnesium, cadmium, strontium, and zinc.

Silver Phosphates and Arseniates.—A. Joly.—The author has examined and described the compounds PO_8Ag_3, PO_8Ag_2H, AsO_8Ag_3, AsO_8AgH_2, and AgO,AsO_5.

Certain Coloured Reactions of the Titanic, Niobic, Tantalic, and Stannic Acids.—Lucien Lévy.—(See p. 300).

New Procedures for Preparing Crystalline Carbonates.—L. Bourgeois.—The author describes the results of two processes in the wet way, both founded on the precipitation of a superheated saline solution by means of ammonium carbonate.

Bulletin de la Société Chimique de Paris. Vol. xlvi., Nos. 5 and 6, September 20, 1886.

Chemico-dynamical Studies on the Reaction of Ferric Salts and of Oxalic Acid under the Influence of Heat.—G. Lemoine.—Ferric chloride and oxalic acid in aqueous solutions are mutually dissolved in the dark under the simple influence of heat. The products are ferrous chloride, hydrochloric acid, and carbonic acid. Ferric sulphate and nitrate undergo a similar decomposition with oxalic acid. The decomposition only begins above 50°, and is accelerated by an increase of temperature. The reaction is also promoted by an addition of water. The author compares the effects of heat to those of light. When the mixture of oxalic acid and of ferric chloride is decomposed in the cold on exposure to the sun, two independent influences come into play: the physical absorption of the active luminous rays and the chemical decomposition of the mixture, this latter taking place according to the same laws as by heat. Various reasons lead him to believe that in the reactions effected by light the

effects observed result simply from the super-position of these two laws.

Distribution of a Base between Two Acids; the particular case of the Alkaline Chromates.—Paul Sabatier.—In such cases Prof. Thomsen considers that the distribution is defined by the relative avidities of the two acids as regards the base, this avidity being a characteristic coefficient of each acid, varying with the base and absolutely independent of the neutralisation heats. On the contrary, M. Berthelot holds that the mechanism of saline reactions may be entirely foreseen according to thermic considerations alone. The author's experiments seem to him decisive in favour of the views of Berthelot.

Reaction of Barium Carbonate and Sodium Sulphate under the Influence of Pressure.—W. Spring.—The author has formerly described results obtained by submitting to intense pressure mixtures of barium sulphate and sodium carbonate, and has found that these two bodies, although both in the solid state, enter into reaction at the ordinary temperature. He has now completed his investigations by the study of the inverse phenomenon, the action of sodium sulphate with barium carbonate. These two substances in fine powder and thoroughly dry were then mixed together and studied under the action of pressure alone, then under that of pressure and time, and lastly under that of pressure and temperature. Pressure alone for a few moments transformed 59·16 per cent of the barium carbonate into barium sulphate. It is to be noted that mere agitation without pressure effected the conversion of 49·79 per cent. In the joint action of pressure and time a limit is reached which marks the end of the reaction. At the temperature of 160° degrees applied for six hours the formation of barium sulphate only reached 34·66 per cent, so that heat interferes with the action of pressure.

Preparation of Calcium Sulphide having a Violet Phosphoresence.—A. Verneuil.—Already noticed.

Researches on Cyclamose.—G. Michaud.—The author has obtained from *Cyclamen europæum* a new sugar of the type $C_{12}H_{22}O_{11}$. Its rotatory power is $-11°40$, and after inversion $-66°54$.

Urethane from an Analytical Point of View.—G. Jacquemin.—If to a solution containing 0·00005 grm. urethane per c.c. there is added potassa and then mercuric chloride drop by drop, each drop of the latter produces a yellow precipitate, which re-dissolves as long as any urethane is present, and finally the yellow precipitate becomes permanent.

Detection of Urethane in Urine.—G. Jacquemin.—Urethane is extracted by means of ether. Three hundred shakings at least are needed, and after decantation it is repeatedly washed with water. The residue after the evaporation of the ether is taken up in very little water and treated as it has been indicated in the foregoing paper.

Moniteur Scientifique, Quesneville.
3rd Series. Vol. xvi., September, 1886.

Patents taken out in Berlin with Reference to Colouring-Matters.—F. No. 2479. Meister, Lucius, and Bruning. March 17, 1886. Process for preparing metoxyquinoxaline.

F. No. 2615. No inventor's name. February 13, 1886. Preparation of blue-green colouring-matters, and more especially of the sulphonic acids of the benzylated pseudo-rosanilines.

Sch. No. 3819. Schœlkopp Aniline and Chemical Company, of Buffalo. December 22, 1885. Red and yellow colouring-matters derived from a new naphthol-disulphonic acid.

B. No. 6519. Baden Aniline Company. February 25, 1886. Preparation of solutions of basic aniline colouring-matters, and of colours for printing by means of the acetines, aceto-chlorhydrines, and chlorhydrines of glycerin.

L. No. 3387. Leipzig Aniline Works. October 21, 1885. Process for preparing blue colouring-matters by the combination of diazo-saffranines with phenols.

H. No. 2728. Alfred Hern, of Bâle. March 17, 1886. Process for preparing chlorides of the dialkylamido-thio-benzoic acids, and of the corresponding acids, as well as of tetra-alkyldiamido-thio-acetones, by means of carbon chlorosulphide and of the tertiary aromatic amines.

P. No. 2732. Pistor, of Bergnenstadt. March 20, 1886. Process for preparing a gall-nut ink. The inventor steeps finely divided metallic iron with a solution of 1 part of pure tannin in 20 parts of water, adding to the product phenic acid, and strengthening the ink by means of suitable colouring-matters. This ink is free from gum, and fast as against air and light.

F. No. 2684. Meister, Lucius, and Bruning. February 1, 1886. Process of preparing compounds of aromatic hydrazines with levulic acid.

MISCELLANEOUS.

Native Alloy of Nickel and Iron.—At the meeting of the Geological Society on December 1st the President announced that he had received from Prof. Ulrich, of Dunedin, N. Z., the announcement of a very interesting discovery which he had recently made. In the interior of the South Island of New Zealand there exists a range of mountains, composed of olivine-enstatite rocks, in places converted into serpentine. The sand of the rivers flowing from these rocks contains metallic particles which, on analysis, prove to be an alloy of nickel and iron in the proportion of two atoms of the former metal to one of the latter. Similar particles have also been detected in the serpentines. This alloy, though new as a native terrestrial product, is identical with the substance of the Octibeha meteorite, which has been called octibehite Prof. Ulrich has announced his intention of communicating to the Society a paper dealing with the details of this discovery—which is certainly one of the most interesting that has been made since the recognition of the terrestrial origin of the Ovifak irons.

The Mineral Resources of the United States, 1885. United States Geological Survey.—We have received, from the chief of the Division of Mining Statistics, a digest of the principal totals of the various mineral products for 1885. These products are classified into metallic and non-metallic. In the first group we note that the annual decrease in value which was apparent in the three previous years is still noticeable, though not to such a great extent in the year with which this report deals. The falling off from 1884 to 1885 is about 5,000,000 dollars, while that in the previous year was over 16,000,000 dollars; the most remarkable fall of value being that of crude platinum, which in 1882, 1883, and 1884 was worth 3 dollars per ounce, is estimated in 1885 at only 0·75 dollar per ounce. In the non-metallic group the decrease of the previous years has disappeared, and an increase of value—20,000,000 dollars—is apparent, principally in natural gas, coal, and anthracite. In spite of this, however, the grand total is considerably lower than that of 1883, when the figures were over 452,000,000 dollars, those in 1885 being a little more than 428,500,000 dollars.

MEETINGS FOR THE WEEK.

Monday, 20th.—London Institution, 5.
—— Medical, 8.30.
Tuesday, 21st.—Institution of Civil Engineers 8.
—— Pathological, 8.30.
Thursday, 23rd.—Telegraph Engineers, 8.
—— London Institution, 6.

THE CHEMICAL NEWS.

Vol. LIV. No. 1413.

CHEMISTRY OF ESTUARY WATER.*

By HUGH ROBERT MILL, D.Sc., F.R.S.E., F.C.S.,
Of the Scottish Marine Station.

Ocean Chemistry has received much attention since the middle of last century, but the results of older workers have been entirely set aside by those of Forchammer,† published in 1865, and of Dittmar,‡ on the *Challenger* waters in 1884. It has been fairly established that ocean water—except at very great depths, where there is a slight increase in dissolved calcium carbonate—differs in various positions only in salinity, *i. e.*, the ocean is composed of solutions of different strengths of a saline mixture of uniform quantitative composition.

Very recently much work has been done by the German Scientific Commission in Kiel, and by the German and Norwegian Governments, in examining the physical and chemical characteristics of the water in the North Atlantic, the Baltic, and the North Sea. None of these researches included estuaries, which form in one sense the most interesting field for marine chemical research, on account of the great variety of changes which may be expected alike in salinity and in the composition of the dissolved solids and gases, brought about by the different nature of rivers and the geological features of the districts they drain.

The first essential to be ascertained in examining the chemical conditions of an estuary is the distribution of salinity, or the ratio of total dissolved salts to the water containing them. This can be ascertained in several ways: the most rigidly accurate is to perform a quantitative analysis, and estimate each acid and base; the next which suggests itself is to evaporate a weighed sample of the water to dryness, and weigh the dried residue, making due allowance for the loss of hydrochloric acid from dissociating magnesium chloride, and of carbonic anhydride from acid carbonates. These are too tedious for systematic use when a number of determinations have to be made; and since recent researches have shown that by determining any one constituent of sea water salts the total dissolved matter can be calculated, and that the density of sea water is a function of salinity and temperature, investigators have been accustomed to measure salinity either by determining the amount of chlorine or the density. The variations from absolute uniformity of composition of the dissolved salts of sea and estuary water do not appear sufficient to invalidate this method for use in river entrances.

The attempt to perform chlorine determinations in a floating laboratory has been discontinued by most chemists, although Tornoe appears to have got good results in this way on the Norwegian expedition. When I commenced work on the chemistry of the Firth of Forth chlorine determinations formed part of the routine observations, but I soon found that, on account of sea spray in the air, it was impossible to make accurate determinations. I consequently employed the hydrometer, and for purposes of general classification used the figures for density reduced to constant temperature (15·56° C. to compare with Buchanan's *Challenger* work) as representing salinity. The hydrometer used was a glass cylinder about a decimetre long, 5 centimetres in diameter, with a loaded bulb below and terminating above in a decimetre-long stem, 3 millimetres in diameter, graduated in millimetres. The instrument was weighed, its volume determined at two temperatures, and the volume of each division of the stem ascertained. In order to adapt it for use in water of any density, small weights of known value could be affixed at the top of the stem. In each case two readings were taken, the first by adjusting the weights so as to read on the lower third of the stem, the second by putting on an additional piece of brass, which sunk it until not more than the upper third remained unsubmerged. From the two readings, and the temperature as taken before and after the observation, the immersed volume and total weight of the hydrometer were obtained, and from these the density was calculated. The mean of the two results was reduced to 15·56°, and taken to represent the salinity of the sample.

Water samples were collected by means of a new form of slip water-bottle,* specially devised for use in shallow water where there are rapid currents, and density was either determined on board the steam-yacht *Medusa*, in the floating laboratory at Granton, or on shore.

The distribution of salinity in the Firth of Forth has been pretty clearly established, and the observations made during the past two and a half years may be briefly enumerated and tabulated.

The River Forth runs east, and at Alloa expands into the estuary, which gradually increases in depth to about 20 fathoms at Inchkeith and 30 near the Isle of May, where the Firth merges into the North Sea close to the mouth of the estuary of the Tay.

Observations of surface, bottom, and intermediate-depth water were made about once a month, at intervals of every 5 miles from Alloa to the Isle of May, a distance of 55 miles, and the stations numbered I. to XII. The figures in Table I. are represented in the curves Fig. 1.

* A Paper read before the British Association, Birmingham Meeting, Section B.

† *Phil. Trans.*, clv., p. 203.

‡ *Chall. Rep. Phys. Chem.*, (1884), vol. i., part 1.

* *Proc. Roy. Soc. Edin.*, January, 1886.

Table I.—*Density at* 15·56° *C.* (60° *F.*) *of Water in Firth of Forth.*

Station.	High Tide.		Low Tide.		All Cases.†					
					Surface.			Bottom.		
	Surf.	Bott.	Surf.	Bott.	Max.	Min.	Mean.	Max.	Min.	Mean.
I.	—	—	—	—	1·00160	0·99923	1·00047	1·00146	0·99939	1·00043
II.	1·01578	1·01891	1·00553	1·00916	1·01981	0·99978	1·01081	1·02020	1·00916	1·01566
III.	1·02073	1·02214	1·01703	1·02056	1·02249	1·01084	1·01888	1·02281	1·01876	1·02124
IV.	1·02235	—	1·02149	1·02385	1·02414	1·01758	1·02192	1·02398	1·02371	1·02385
V.	1·02342	1·02448	1·02303	1·02447	1·02461	1·01863	1·02323	1·02509	1·02366	1·02448
VI.	1·02406	1·02562	1·02357	1·02486	1·02496	1·01953	1·02383	1·02562	1·02484	1·02505
VII.	1·02485	1·02497	1·02471	1·02494	1·02528	1·02380	1·02477	1·02533	1·02419	1·02496
VIII.	1·02502	1·02531	1·02501	1·02538	1·02555	1·02450	1·02501	1·02562	1·02514	1·02535
IX.	1·02515	1·02533	1·02512	—	1·02553	1·02465	1·02513	1·02541	1·02526	1·02533
X.	1·02522	1·02554	1·02530	1·02508	1·02563	1·02470	1·02526	1·02554	1·02508	1·02531
XI.	1·02542	—	1·02521	1·02530	1·02566	1·02417	1·02532	1·02571	1·02424	1·02530
XII.	1·02552	1·02549	1·02534	1·02554	1·02570	1·02443	1·02546	1·02562	1·02460	1·02531

At Inchkeith there is practically no tidal range of salinity, but further up the estuary there is considerable difference between salinity at high and low tide; the shoaling of the river above Queensferry does not appear to affect the increasing divergence of the curves (see fig. 1). The great uniformity and close approximation of surface and bottom salinity in the outer half of the Firth is extremely interesting, for it shows the river diffused in a homogeneous manner through a wall of salt water, which is never the case in a stream running directly into the sea, Beyond the Isle of May there is a dip in the line of surface density not followed by that for the bottom. This I have shown to be due to the influence of the River Tay.*

As a whole the Firth seems to be in a state of equilibrium as regards salinity; the fresh water entering it must pass through it at a definite rate, and bear a constant ratio to the sea-water at each point. It is a matter of much interest to find this ratio, and thence to deduce the actual amount of each kind of water in the Firth.

Wnen river- and sea-water mix a slight contraction takes place, but this may be disregarded at the present stage of the enquiry; and by assuming that fresh and salt water mix without change of volume, and taking 1·000 as the density of river water and 1·026 as that of sea water, the percentage of each at different parts of the Firth has been calculated, and is shown in Table II. The Table also shows the number of square yards of cross section occupied by each kind of water—supposing the river water to be separated from the sea water—at each station 5 miles apart.

TABLE II.

Station.	High Tide. Per cent.		Low Tide. Per cent.		Mean of all Tides. Square yds. in cross section.	
	Fresh water.	Sea water.	Fresh water.	Sea water.	Fresh water.	Sea water.
I.	95·5	4·5	100·0	0·0	776	37
II.	38·2	61·8	76·8	23·2	1,358	1,532
III.	19·8	80·2	33·7	66·3	2,440	8,660
IV.	13·5	86·5	16·8	83·2	3,900	26,100
V.	9·7	90·3	11·2	88·8	4,040	47,960
VI.	7·1	92·9	9·0	91·0	7,360	107,640
VII.	4·5	95·5	—	—	12,100	289,900
VIII.	3·7	96·3	—	—	16,700	579.300
IX.	3·5	96·5	—	—	17,100	626,900
X.	2·6	97·4	—	—	16,800	630,200
XI.	2·6	97·4	—	—	25,300	945,700
XII.	1·9	98·1	—	—	30,300	1,562,700

The Firth of Forth contains 824×10^6 tons of river water; and at low tide $28,000 \times 10^6$ tons of sea water, with 4000×10^6 tons of sea water additional when the tide is high. The total volume of the Firth at low water is $36,700 \times 10^6$ cubic yards, according to the soundings of the Admiralty charts. The discharge of river water is about 11,000 cubic yards a minute at Alloa, so that, if no other supply were available, two years' accumulation of river water exists in the Firth of Forth. The freshening influence of rain is probably too small to affect this value much; the various tributary rivers must modify it to some extent, but their action cannot be allowed for as their discharge is unknown.

The figures in Table II. show an actual increase in the amount of fresh water diluting the sea water in each successive section of the Firth, and this increase—analogous to that observed by Birch in the Thames—is too great to be wholly accounted for by the contributions of tributaries. It is evident to my mind that in the outer part of the Firth of Forth diffusion is the great agent in carrying river water seaward; and as the diffusion takes place across sections where the difference in salinity of the substances diffusing into each other becomes less and less, the rate must become slower and slower. An accumulation of river water in the seaward reaches would thus be accounted for, since in each very thin slice the difference of salinity on the side by which the fresher water enters is greater than that on the side by which it leaves, and *cæteris paribus* the rate of diffusion is proportional to difference in salinity.

The Clyde water system differs completely from that of the Forth, and a different distribution of salinity has been found there. Table III. shows the density of water in the Firth of Clyde and in the Clyde sea-lochs, in April and June this year. It may be viewed as an extension of Macadam's paper read to this Section in 1855.* Each of the regions for which the density is given was examined in four or five places, samples of water taken at surface, bottom, and intermediate depths, and the mean of all the samples taken for each position put down on the table. The Firth of Clyde is barred by a plateau rising to within 25 fathoms of the surface at its communication with the sea; inside it is the deep Arran basin of over 80 fathoms, and indirect communication, so far as surface water is concerned, the separate basin of Upper Loch Fyne. Loch Strivan is a similar smaller basin, communicating with the Kyles of Bute on one side, and with the Firth between the Arran and Dunoon Basins on another. The Dunoon Basin bears the same same relation to Loch Long and Loch Goil than the Arran Basin does to Loch Fyne, but it is further up the estuary. The Holy Loch is a shallow bay, and the Gare Loch a shallow basin connected with the upper part of the estuary. The sea-lochs, as a rule, preserve at the bottom water of the salinity that prevails in the Firth at their mouth; while in several cases, notably in that of Loch Long, the surface water is greatly diluted by streams and temporary torrents.

The whole mass of water was fresher in April than in June, a result comparable with the state of matters in the Baltic, as determined by the Kiel Commission, and probably due to a similar reason, the melting of snow. The curve of salinity from river to sea along the estuary and firth of Clyde appears to resemble that for the Forth; but it has not yet been sufficiently worked up to enable one to form an exact judgment. The curves for the Tay and

* *Proc. Roy. Soc. Edin.*, xiii. (1885), p. 347.

* *Brit. Assoc. Rep.*, (1885) ii., 64.

TABLE III.

Place.	April, 1886.		June, 1886.		Mean of April and June.	
	Surf.	Bott.	Surf.	Bott.	Surf.	Bott.
Irish Channel	1·02535	1·02532	1·02533	1·02534	1·02528	1·02533
Clyde Plateau	1·02398	1·02504	1·02479	1·02528	1·02438	1·02516
Arran Basin	1·02256	1·02509	1·02460	1·02504	1·02358	1·02507
Loch Fyne..	1·02417	1·02471	1·02439	1·02480	1·02428	1·02476
Loch Strivan	1·02346	1·02483	1·02458	1·02490	1·02402	1·02485
Kyles and Loch Ridush ..	1·02317	1·02401	1·02438	1·02484	1·02378	1·02442
Dunoon Basin	1·02037	1·02469	1·02369	1·02487	1·02203	1·02478
Holy Loch..	1·01438	1·02415	1·02228	1·02426	1·01833	1·02420
Loch Long	1·01557	1·02439	1·01661	1·02442	1·01609	1·02440
Loch Goil	1·02036	1·02449	1·02384	1·02452	1·02210	1·02450
Gareloch	1·02052	1·02345	1·02329	1·02340	1·02190	1·02343

Table IV.

Station.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Surface..	56·1	56·2	56·2	54·5	52·9	52·7	52·9	52·8
Bottom..	54·1	—	53·0	—	52·7	—	—	—

Speaking generally we can say that alkalinity increases when density decreases, or when the river-water relatively rich in carbonates increases in amount.

Near the river Spey, which has no estuary, alkalinity was found to increase as soon as the brackish water surrounding the river mouth was entered from the sea.

The most difficult, and perhaps the most important, part of chemical research on estuaries has not yet, to my knowledge, been commenced. It is the investigation of dissolved gases, their nature and amount, as influenced by salinity. For this it is necessary to know the salinity in the first place, and its variation from point to point. This preliminary work is what I have been principally engaged in.

NEW PROCESS FOR THE VOLUMETRIC DETERMINATION OF ZINC IN POWDER.

By F. WEIL.

The author's processes for the volumetric determination of copper by means of hydrochloric acid in very large excess, and of stannous chloride, which he has already applied to the speedy and exact titration of antimony, iron, sulphur in sulphides, sugar, and glucose, have led him to a quick and accurate method for titrating the metallic zinc in zinc-powder and granulated zinc.

He prepares a copper solution such that 10 c.c. may contain exactly 0·1 grm. of pure copper. For this purpose he dries, in a porcelain capsule, pure copper nitrate, the final ignition of which is completed in a platinum crucible over a Bunsen. The pure copper oxide thus obtained is let cool in a desiccator, and 12·519 grms. are weighed out and dissolved in a slight excess of pure hydrochloric acid with the aid of heat. The liquid is then made up with distilled water to the exact volume of 1 litre. It is stirred up, and thus yields a normal solution, 10 c.c. of which contain exactly 0·1 grm. of pure metallic copper.

By means of a pipette 50 c.c. of this liquid are placed in a porcelain capsule, and neutralised with ammonia until a slight turbidity appears, which does not disappear on stirring. At this moment the liquid should still be faintly acid. The portion weighed out for analysis (0·4 grm. of the zinc powder) is let fall to the bottom of the capsule, and this little heap is covered with a platinum wire, which is coiled up at its lower end into a flat spiral, whilst the stem stands up out of the bath to serve as a handle for stirring occasionally.

The zinc precipitates copper equivalent for equivalent. The operation at the ordinary temperature may be completed in ten minutes if a platinum capsule is used. The end of the reaction is indicated exactly by a platinum wire with which the powder at the bottom of the liquid is touched. If any zinc remains undissolved the wire becomes coated with a slight black or red layer. If, on the contrary, the platinum indicator remains of a bright white, all the zinc is dissolved and the operation is at an end. The platinum wire is then withdrawn, washed with the washing bottle, and acetic acid is poured into the capsule, drop by drop, to render limpid the liquid at the bottom of which is the reduced copper. The supernatant solution is decanted into a vessel graduated at 100 or at 200 c.c. The capsule and the copper are sufficiently washed with distilled water; the washings are added to the bulk of the liquid, which is then made up to 100 or 200 c.c. It is stirred, let settle, if needful for some minutes; 10 c.c. of the clear liquid are put into a small flask of white glass. From two to three times its volume of pure hydrochloric acid are added, and the liquid is titrated at a boil until completely decolourised with a solution of stannous chloride which has been standardised with a dilute solution of copper containing 0·04 grm. of pure copper in 10 c.c. The result shows the quantity of copper in excess remaining in the solution. On deducting it from the 0·5 grm. of copper used we obtain the weight of copper precipitated by the sample of zinc. On multiplying it by the coefficient 1·0236—

$$\left(\frac{Zn=32·5}{Cu=31·75}=1·0236\right),$$

we find the quantity of metallic zinc contained in the 0·4 grm. of zinc powder operated upon.—*Comptes Rendus*, vol. ciii., p. 1013.

NOTE ON THE ANALYSIS OF HOOFS AND HORNS.

By JOHN HUGHES, F.C.S., F.I.C.

Finely ground hoofs and horns, sometimes called keronikon, are now used by manure manufacturers as an economical material for supplying organic nitrogen in a concentrated form.

It contains from 14 to 15·35 per cent of nitrogen, and though naturally hard and tough, yet when ground and treated with acid it soon becomes resolved into available plant-food.

As sampled on delivery at the works, it is in the condition of a granulated meal, of a brown colour, and sufficiently fine that the greater part will pass through a sieve having holes $\frac{1}{16}$ inch diameter.

This is rather too coarse for the analysis, especially as the mineral impurities consist of dirt, sand, small stones, and particles of iron, which requires that a fair portion should be ground up into a fine powder previous to weighing 0·7 and 0·6 grm. respectively for duplicate nitrogen determinations.

Now during the process of grinding in an iron mortar the material becomes more hygroscopic, and as it is reduced to a fine powder absorbs moisture in proportion to the increased surface presented to the atmosphere, this property being specially marked during damp weather, such as at presents obtains, and in the case of samples which are richest in nitrogen and have least foreign impurity.

It follows, therefore, that the fine portion analysed contains less nitrogen than the original coarse sample received, and it is necessary to make a proportional correction in the form of a slight addition in order to obtain the correct results for the certificate.

To what extent this increase of moisture applies will be seen from the following particulars in three samples:—

I. In fine portion analysed—

	A.	B.	C.
Water dried at 212° F...	5·03	6·52	6·30
Mineral matters	4·50	4·85	7·52
Organic matters	90·47	88·63	86·18
Containing nitrogen ..	14·80	14·53	13·96

II. In coarse sample received—

Water dried at 212° F...	3·14	5·73	5·33
Nitrogen (calculated) ..	15·09	14·65	14·11
Equal to ammonia ..	18·32	17·78	17·13

The quantities of the coarse and fine taken for the water determinations were in each case the same, as well as the length of time allowed for drying.

The portions from B sample were spread out on paper over night and re-weighed the next morning, when it was found that not only was the water previously driven out

by drying re-absorbed, but there was a substantial increase, the fine portion containing 8·12 and the coarse portion 6·32 of water.

In the case of another sample, the fine portion, which had lost 4·66 by drying, was allowed to remain over night in the platinum basin just as taken from the balance and without being in any way disturbed or spread out, and when re-weighed was found to contain 6·49 per cent, having, in fact, absorbed an additional 1·83 per cent of water—the temperature of the room being about 50° F. and the weather damp.

It is evident, therefore, that fine grinding materially increases the hygroscopic properties of such hoofs and horns; and although the correction in the nitrogen due to the absorbed water is really not usually very large, it nevertheless should be made. This is the more necessary as many commercial contracts require that when the ammonia results of the two selected chemists differ more than 0·50 per cent, another sample is to be sent to a third chemist.

In a "Note on the Analysis of Shoddy," published in the CHEM. NEWS (vol. xlii., p. 325), 1880, the writer pointed out that the chief cause of the frequent and great differences in the ammonia results which then existed was chiefly caused by the omission of some chemists to make the necessary correction for the moisture lost during the preparation of the sample. The consequence being that the results were reported much too high, especially in those cases where the official samples were at all damp. In fact, the ammonia was given as found in the partially-dried portion analysed instead of for the original damp sample received.

In the analysis of ground hoofs and horns, however, it is probable that the results sent off are not unfrequently rather too low, especially as these highly nitrogenous materials require special care and attention in order to get the whole of the nitrogen compounds converted into ammonia during the process of combustion.

Having had some experience in testing these samples, it may be of use to mention that it is desirable to be liberal in the quantity of soda-lime; at least 20 grms. should be mixed with the 0·7 grm., and a couple of inches of it should be in front of the nitrogen mixture; while the time allowed for burning should be not less than 1½ to 2 hours.

Finally, from the fact that of the two determinations always made, the one in which 0·6 grm. was mixed usually gave the higher result as compared with 0·7 grm. and similar quantities of soda-lime, it is believed that the whole of the nitrogen is scarcely ever completely recovered as ammonia, and that, consequently, the higher results when obtained should be regarded as the more correct.

Analytical Laboratory, 79, Mark Lane, E.C.,
Dec. 13th, 1886.

REICHERT'S METHOD OF BUTTER ANALYSIS.*

By H. B. CORNWALL and SHIPPEN WALLACE.

THE authors recommend that Reichert's process be performed as directed by himself (*Zeits. f. Anal. Chem.*, 1879, p. 68), because it is a strictly comparative one, not to be arbitrarily altered. Their experiments with an inverted condenser show that there is no appreciable loss by escape of butyric ether. It is important to make a blank test with the alcohol and potash employed. The authors did this, and also deducted the amount of decinormal alkali solution thus consumed from the results of their tests on butters.

The especial object of the paper was to test the correctness of Reichert's conclusions as to the average and minimum standards for butter, and also Munier's proposal to greatly lower Reichert's standard for certain seasons of the year (*Zeitschrift*, 1882, p. 394). Munier's proposed standard was 10 c.c. of decinormal alkali (for 2·5 grms. of pure butter fat) from October to March; 12·1 c.c. from March to May; 12·4 c.c. from May to August; and 11 c.c. from August to October.

The average quantity of decinormal alkali consumed by the authors was 13·68 c.c. They tested eighty pure butters, made in three widely different parts of the State, for this purpose, and each butter from the milk of a single cow. The results indicated that there was no apparent connection between the c.c. of decinormal alkali consumed and any of the following conditions: season of the year; breed, food, or age of the cows; or time after calving. The average in the case of one series of tests was actually higher for November and December than for September and October.

The authors are unwilling to accept Munier's results until further confirmed, for the following reasons:—First, he appears to put little confidence in his own results, because he found one butter (in December) consuming only 9·2 c.c. of decinormal alkali, and yet he does not propose a lower standard than 10 c.c. even for December. Second, his figures are, for the most part, very low as compared with all other observers, his average for sixty-nine butters being only 12·07 c.c., against an average of 13·89 for 162 butters reported by eight or ten other experimenters, including the authors, some of the experimenters having purposely selected Dutch breeds of cows. Notwithstanding that Munier's results have been attacked by several writers, the authors have not seen any reply to the criticisms, nor any defence of the figures obtained by him from butters furnished by the "Israelitische Molkerei" and other Amsterdam creameries.

The authors recognise the fact that the proportion of volatile (soluble) fatty acids obtainable from different pure butters may vary much, and therefore strongly recommend that tests made with a view to establishing minimum and maximum standards for the fatty acids (whether soluble or insoluble) should be made on butters known to be the product of single cows, such butters often being offered for sale.

The authors find it necessary to recommend that the standard for butter (unless surely known to be made from the mixed milk of several cows) should be made lower than the 12·5 c.c. proposed by Reichert, or even the lower limit of 11·5 to 12 c.c. proposed by Sendtner (Wagner's *Jahresbericht*, 1883, p. 979). One cow was found to yield butter requiring only from 11·3 to 11·5 c.c. of decinormal alkali (after deduction of 0·3 c.c. for the decinormal alkali consumed in a blank test, as already described). Butter was made from the milk of this cow in the beginning and at the end of December, and it was tested by both of the authors, each working in his own laboratory and with entirely different sets of reagents. They obtained identical results, and therefore believe that, for butter from the milk of a single cow, the minimum standard cannot safely be above 11 c.c. of decinormal alkali consumed in Reichert's test, when 2·5 grms. of fat are taken.

The cow yielding this butter was one of a herd of eight cows in Princeton, New Jersey. She was of mixed breed, chiefly Alderney; was nearly five years old; had a calf eight months before, and was expected to have another in the following May; she yielded at the time from six to seven quarts (roughly estimated) of good milk daily; was fed on barley meal and corn-stalks (maize), and appeared to be in good condition. The butter, made separately from five other cows in the same herd, at nearly the same time, used from 12·2 to 15·1 c.c. of decinormal alkali, so that neither the season of the year nor the food appears to have had any influence on the result.

In case of butter made on the large scale, from the mixed milk of several cows, the standard above proposed

* Abstracted from the Ninth Report of the State Board of Health of New Jersey, U.S.A., by H. B. Cornwall.

(11 c.c.) is practically equal to the usual one of 12 c.c., because such butter cannot be profitably adulterated without falling much below either standard when tested by Reichert's process.

The authors are very strongly in favour of Reichert's process, both because it is the most rational of the common quantitative methods for testing butter (being founded on the true difference between genuine and imitation butter, which is the amount of readily volatile fatty acids in the two), and because it is as thoroughly a quantitative method as any other, so far as regards the conclusions to be deduced from it. A chemist can announce beforehand (within certain reasonable limits) how much decinormal alkali will be consumed in the Reichert test on a mixture of pure butter fat and a foreign fat (lard, for instance) mixed in known proportions. Can any one do more by any method? Before a Court of Law he can affirm positively that a certain fat is not pure butter, because pure butter always consumes at least so much (say 11 c.c.) of decinormal alkali when tested by Reichert's method. What more definite answer can be required? Aside from its accuracy, the greater facility of Reichert's method should secure its adoption in these days, when so many food analyses are made.

But more than this can be said: one of the authors met with an imitation butter which by Hehner's method yielded only 88·2 per cent of insoluble fatty acids. This butter would have passed as pure by that test, but the Reichert process showed it to be impure (as it really was, being an imitation made from lard and butter, and known as "sueine"), because it only consumed 4·2 c.c. of decinormal alkali.*

ON THE

MICRO-CHEMICAL ANALYSIS OF MINERALS.

By T. H. BEHRENS.

(Concluded from page 302.)

The preceding pages contain the results of a research which I undertook in order to satisfy in some measure the wants and necessities of petrographers. In the course of my work my notice has been attracted by other reactions which would serve to indicate the presence of the rarer elements. I propose communicating them at some future time, provided no other person has got ahead of me in this field. The method I propose, and which is based on the transformation of silicates into sulphates, has so great an analogy to the methods ordinarily in use in qualitative analysis that it is highly probable that we shall be able to apply the test to a much greater number of elements: the certainty of the results obtained, the rapidity of carrying out the reactions, and the modest dimensions of the apparatus required, might have induced me to persist for a longer time in researches of this nature, if I had not been convinced that I ought to use all my available time in studying the second part of this question, the most difficult part of my work, that which aims at finding reactions which will indicate the presence of several chemical compounds on the polished surface of a mineral.

For this reason I have decided to publish the results obtained up to the present, results which leave nothing to be desired in the way of certainty.

I have not hesitated to introduce some of the more important reactions into the practical work of the students at the Ecole Polytechnique, such as the test for potassium, calcium, magnesium, and aluminium. This succeeded completely. I can therefore, in full confidence, recommend young microscopists to avail themselves of the methods I have described in the foregoing pages.

If this application of these methods is followed up, it will without doubt lead to the discovery of new and improved ones; I feel convinced that they will be well received by petrographers and microscopists. I for myself shall be only too pleased at every success which may be achieved in this class of research.

To enable the degree of accuracy which can be obtained to be properly judged, and also to make the manner of proceeding as clear as possible, I shall now, in the form of an Appendix, give the details and the results arrived at of several analyses made by me with weighed samples of minerals.

22. *Control Analyses.*

(1.) 0·2 m.grm. of black tourmaline was heated with hydrofluoric acid. The action was very weak. After heating the powdered mineral very strongly, I succeeded in dissolving about half of it. The dried mass was warmed with sulphuric acid until the action was nearly finished; the residue was boiled with water; and finally the solution, which was about 0·015 c.c. in volume, was taken up by means of a capillary pipette.

Half the solution, evaporated on a plate of glass, gave very distinct crystals of gypsum, and with chloride of cæsium such a plentiful supply of cæsium alum was formed that one-fifth part of the liquid would have been sufficient to observe the reaction. The other half, saturated with ammonia, gave, after adding a small quantity of phosphorus salt, in the space of about two minutes, a large number of hemimorphic crystals of ammonio-magnesic phosphate.

It will be seen that I did not use more than 0·05 m.grm. of tourmaline for each test, taking the inevitable loss into account. If we admit that this mineral contains 3·3 per cent of alumina, 1 per cent of lime, and 3·3 per cent of magnesia, we get the following results:—

Abundant reaction with	0·017 m.grms. of	Al_2O_3,
Sufficient	0·0017 ,,	MgO,
And	0·0005 ,,	CaO.

(2.) 0.2 m.grm. of sodalite was decomposed by sulphuric acid; the residue, after evaporation, was boiled with water, and the solution—taken up with a capillary pipette—was divided into two equal parts. One of these halves gave good crystals of gypsum, and with chloride of cæsium a few but very distinct crystals of alum were formed.

The second portion, treated with perchloride of platinum, gave numerous octahedra of potassic chloroplatinate. This result, although rather surprising, was confirmed by another trial, using hydrofluoboric and hydrofluosilicic acids as reagents. The formation of the corresponding sodic salts took a considerable time,—in fact the liquid was almost entirely evaporated; the reaction was not so distinct as I could have wished. A tenth of a m.grm. of sodalite corresponds to—

0·03	m.grm. of	Al_2O_3,
0·001	,,	CaO,
0·0006	,,	MgO,
0·0023	,,	Na_2O.

(3.) 0·1 m.grm. of sodalite was distilled with sulphuric acid in a crucible with a platinum cover. The distillate and the residue, dissolved in water, both gave distinct indications of the presence of chlorine by the reaction with chloride of thallium. If we admit that half the chlorine would go into the distillate, we arrive at the result that we can detect 0·035 m.grm. of chlorine, which corresponds to 0·006 m.grm. of NaCl and 0·05 m.grm. of sodalite.

(4.) 0·2 m.grm. of apophyllite from Andreasburg, warmed with hydrofluoric and sulphuric acids in a crucible with the platinum cover, gave a distillate which deposited

* A similar proof of the accuracy of Reichert's method has been met with in the writer's experience. A butter was tested by Hehner's method, by a New York chemist of great experience in such work. He reported the butter as of doubtful purity. Tested by Reichert's method subsequently, it consumed 9·2 c.c. of decinormal alkali, and the writer unhesitatingly pronounced it impure. It was finally acknowledged to be so by the dealer. It was one of the so-called "gilt-edge" imitations, which are perhaps not as often detected as they should be.—H. B. C.

an abundant quantity of fluosilicate of soda, on the addition of sodic chloride. The residue in the crucible was evaporated to dryness, warmed again with a little dilute sulphuric acid, until the sulphuric vapours commenced to be given off, then dissolved in water. Half the liquid, when treated with chloride of cæsium, gave a small quantity of alum and abundant crystals of gypsum. Ammonio-sodic phosphate and ammonia gave no reaction whatever. The other half, treated with perchloride of platinum, produced an abundant crystallisation of potassic chloroplatinate.

I did not succeed in detecting the presence of sodium either with cerous sulphate or with hydrofluosilicic acid.

0·2 m.grm. of apophyllite corresponds to 0·1 m.grm. of silicic acid, half of which would have been detected with the greatest ease; 0·1 m.grm. of apophyllite contains 0·026 m.grm. of CaO and 0·005 m.grm. of K_2O.

As for aluminium. this metal is only mentioned once (1·5 per cent) by Rammelsberg,* as a component part of apophyllite; thus the reaction with cæsic chloride was successfully carried out with 0·0015 m.grm. of alumina.

As hydrofluoric acid might contain traces of alumina, the experiment was repeated with 0·3 m.grm, of apophyllite and concentrated sulphuric acid without the addition of hydrofluoric acid.

The distillate gave, with sodic chloride, a slight crystallisation of sodic fluosilicate, a certain proof of the presence of fluorine. The residue gave abundant crystals of cæsium alum on the addition of cæsic chloride.

If we take the percentage of fluorine in apophyllite, which according to different writers varies from 0·46 to 1·71 per cent (according to Rammelsberg† apophyllite from Andreasburg contains 1·18 per cent of fluorine), as 1 per cent, we find the limit of sensitiveness of the reaction to be 0·003 m.grm. of fluorine.

(5.) 0·4 m.grm. of boracite was distilled with sulphuric acid; the distillate gave, with thallous sulphate, an intense reaction, indicating the presence of chlorine. After having added hydrofluoric acid to the residue, it was redistilled at a moderate temperature. The volatile product obtained only gave traces of fluoborate with potassic chloride; the same result was found with a product obtained at a more elevated temperature.

In a third experiment the temperature was raised until greyish vapours commence to be given off; the distillate obtained, when treated with potassic chloride, gave, after about five minutes, abundant rhombs and elongated hexagons. The residue was dissolved in water. A fourth part of the liquid, when treated with ammonia and phosphorus salt, gave abundant crystals of ammonio-magnesic phosphate.

0·4 m.grm. of boracite	= 0·034 m.grm.	of	chlorine.
0·4 ,, ,,	= 0·25 ,,		boric acid.
0·1 ,, ,,	= 0·031 ,,		magnesia.

(6.) 0·2 m·grm. of axinite was gently warmed with sulphuric and hydrofluoric acids; the volatile product, when treated with sodic chloride, gave abundant crystals of sodic fluosilicate. The residue was again distilled with hydrofluoric acid at a higher temperature, and the vapours were condensed in dilute sulphuric acid.

This distillate, warmed with a drop of hydrofluoric acid until it commenced to take a brown colour (caused by the decomposition of the organic matter coming from the gutta-percha), was mixed with a little water, placed on a plate of varnished glass, and treated with potassic chloride. After the lapse of three minutes I obtained rhombs of potassic fluoborate and some few octahedra of the corresponding fluosilicate.

The residue left in the crucible was treated with boiling water. A third part of this liquid, when treated with chloride of cæsium, gave crystals of cæsium alum; another third gave the same after the reduction of the iron by a few grains of zinc. In the last portion I detected a large quantity of magnesium by means of the reagents. In all these experiments large quantities of crystals of gypsum were found.

0·2 m.grm. of axinite		= 0·1	m.grm.	of	SiO_2.
0·2 ,, ,,		= 0·008	,,		BO_3.
0·07 ,, ,,		= 0·012	,,		Al_2O_3.
0·07 ,, ,,		= 0·0014	,,		MgO.
0·07 ,, ,,		= 0·013	,,		CaO.

The first and last were very abundant.

(7.) With 0·2 m.grm. of datholite, treated in the same manner, I obtained sufficient indications of the presence of boron, and an abundant quantity of fluosilicate, indicating the presence of silicon.

In the residue were found quantities of crystals of gypsum, but no results were obtained with cæsic chloride or with the salt of phosphorus and ammonia.

0·2 m.grm. of datholite	= 0·076	m.grm.	of	SiO_2.
0·2 ,, ,,	0·04	,,		BO_3.
0·2 ,, ,,	0·084	,,		CaO.

(8.) 0·5 m.grm. of pyknite from Altenberg was melted with double its volume of soda; about half was dissolved in concentrated acetic acid. The liquid was evaporated to dryness with sulphuric acid, which is easily done without loss. The product of the distillation, treated with sodic chloride, gave abundant crystals of sodic fluosilicate—a sure sign of the presence of fluorine. 0·2 m.grm. of pyknite contains 0·037 m.grm. of fluorine.

(9.) Felspar from the grey porphyry from Elfdalen, in Sweden, was treated with ammonic fluoride and hydrochloric acid; the mass was then evaporated with sulphuric acid. A large quantity of gypsum was obtained. Perchloride of platinum indicated the presence of a considerable quantity of potassium; cerous sulphate showed the presence of the two alkaline metals, the sodic salt being much more plentiful than that of potassium.

(10.) The examination of a felspar contained in a rock found at Mangenbach, and which has been called Labrador porphyry, proved that the mineral contained a little calcium, more potassium than the preceding mineral, and a preponderating quantity of sodium.

(11.) Felspar taken from the corsite of St. Lucia, in Corsica. The felspathic needles from the nodules have the same composition as the imperfectly formed crystalline grains, from the stony mass which surrounds the nodules. These two species are very rich in calcium; however, they are not pure calcic felspars; in fact, they contain appreciable quantities of potash and soda.

(12.) Bisilicate of the corsite from St. Lucia. The black powder first takes a greenish tint when attacked with hydrofluoric acid; it then becomes pale and dissolves. This behaviour makes us suspect that the mineral contains some felspathic matter. The examination shows that it contains, besides a large quantity of calcium and magnesium (which confirms the supposition that the mineral is hypersthene), a considerable quantity of potassium and aluminium, and what is very important, these results were obtained with those apparently homogeneous pieces taken from different samples.

* "Mineralchemie," 1860, p. 505.
† *Ibid.*, p. 505.

Nitrogenous Principles of Vegetable Mould.—MM. Berthelot and André.—The vegetable mould contains a notable proportion of nitrogen. This proportion generally reaches one or two thousandths. Nitrogen exists chiefly in the soil in the form of quaternary organic compounds, almost totally insoluble. The authors find that these little-known principles are amidic bodies, which behave like albumenoid principles, and which generate under the influence of acids, alkalies, and even pure water, a certain proportion of ammonia, and a larger proportion of soluble amidic compounds. The ammonia furnished by the soil experimented on by the authors results almost entirely from certain splittings up effected under the influence of hydrochloric acid at the expense of the insoluble amidic compounds.—*Comptes Rendus*,

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAIL SAMPLES OF THE WATER SUPPLIED TO LONDO FOR THE MONTH ENDING NOVEMBER 30TH, 1886.

By WILLIAM CROOKES, F.R.S.,

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, December 4th, 1886.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 182 samples examined, the whole were found to be perfectly clear, bright, and well filtered.

The proportion of organic matter present in the water, though somewhat above that met with in the previous months' supplies, continued low, especially for the season of the year. The mean proportion of organic carbon present in the Thames-derived supply was 0·167 part in 100,000 parts of the water, as against a mean of 0·140 part in the supply of the previous month.

The several series of bacteriological experiments described in our previous reports having been made with water as supplied for domestic use, sterilised or not in different instances, the series of experiments now to be described was made with water taken directly from the Thames and its tributary the Cherwell. In the conduct of these experiments it was requisite both by preliminary and contemporaneous study, to distinguish between growths set up by the forms of microbe life proper to running water, and those set up by the purposely introtroduced *Bacillus anthracis*. In many cases the naked eye differences were found not to be sufficiently distinctive, but a recourse to microscopic examination, aided by a staining of the growths with different dyes, always enabled the nature of the growth to be satisfactorily determined. Fourteen duplicate experiments, or twenty-eight infections were made, but, one tube becoming accidentally broken, only twenty-seven results were observed. The experiments were made in the same manner as those previously described. The proportion of infecting animal fluid formed, as nearly as might be, 1-700th of the river water to which it was added. The several infections were made in the last days of June and early part of July, the temperature of the water ranging from 68° to 71° F. (20° to 21·5° C.).

In the last recorded series of thirty-four infections, the tubes of sterilised culture-fluid sown with the infected water within half-an-hour of its having been infected, and then submitted to incubation, exhibited in every case a characteristic bacillar growth. But in the series now under consideration, made with fresh river water, eighteen out of the twenty-seven tubes of sterilised culture-fluid sown with the infected water within half-an-hour of its having been infected, exibited on incubation, not any growth whatever of the bacillus; while even in the other nine cases, the pathogenetic growth seemed more or less attenuated by the various growths wherewith it was accompanied. This result was quite in accordance with the conclusion come to by other investigators, namely, that in the struggle for existence, the microbe forms proper to running water outgrow and starve out the introduced morbific forms.

In each of the twenty-seven instances the sowings were reported after an interval of six hours from the original infection of the river-water, and in every case the sowing proved to be infertile in respect to the foreign infective bacillus; or in no case was the life of the bacillus in the purposely infected river-water found to extend beyond six hours, while probably in no case did it extend to anything like so long.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 305.)

DR. JENKINS then brought up the subject of the Thomas-Gilchrist Schlage, which he said were beginning to be introduced into this country. As they contain phosphide of iron, the phosphorus so combined would be oxidised by nitric acid and determined as phosphoric acid. As the amount reaches 1 per cent at times, this oxidation should be guarded against.

DR. JENKINS also brought up the subject of the effect of the presence of fluorine on the determination of P_2O_5 in phosphates, such as fluorapatite. DR. WHITE said that the small amount of fluorine in Charleston rock had been found to make no difference.

Prof. MYERS then asked in regard to the presence of silica in a soluble form.

Drs. JENKINS and WHITE and Prof. STUBBS mentioned experiments in which the presence of silica to the extent of 10 per cent had no effect. DR. WHITE then contributed the following:—

To Determine the Effect Silica in Solution has upon Molybdate Determinations.

A highly siliceous phosphate from South Georgia was used. It contained total silica, 10·76 per cent.

	Per cent.
Dissolved by boiling in strong HCl	0·11
Dissolved by ignition with $Mg(NO_3)_2$ and solution in strong HCl	0·21

(*a*) 0·5 grm. was digested with 30 c.c. of concentrated HCl, diluted, allowed to settle, poured off, the residue repeatedly boiled with strong HCl, the fluids mixed, and P_2O_5 determined.

(*b*) 0·5 grm. was ignited with $Mg(NO_3)_2$, dissolved in strong HCl, as above, and P_2O_5 determined.

(*c*) 0·5 grm. was treated as in (*b*), an aliquot of the filtrate was evaporated to remove silica in usual manner, and P_2O_5 determined. Results were as follows:—

	a.	*b.*	*c.*
Total P_2O_5	22·54 22·58	22·65 22·60	22·59 22·61
Mean	22·56	22·63	22·60

The indications are that the small percentages of silica brought into solution in the ordinary work of members of this association do not appreciably affect the results in

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

P_2O_5. It may be assumed that it is not necessary to rid the solutions of silica.

Dr. Gascoyne found that the presence of silica had no effect on the determination of phosphoric acid by the molybdate method.

An experiment with a mixture of nine parts of acid phosphate and one part finely ground silica gave 14·93 per cent of P_2O_5 as the average of five determinations by the official method, and 14·92 per cent P_2O_5 as the average of five determinations of the nitric acid method. Three determinations, made by evaporating to dryness, igniting, and re-dissolving in HCl, gave 2·89 per cent as the average.

In discussion of these papers on the use of nitric acid instead of hydrochloric acid and magnesium nitrate, Dr. Jenkins said:—

The reasons which led to the adoption of hydrochloric acid as a solvent and magnesium nitrate as an oxidising agent are the following:—Hydrochloric acid dissolves all phosphates more rapidly, though not more completely than nitric acid, if sufficient pains are taken with the latter, but less time and watchfulness are needed when HCl is used, and for these reasons it has the preference. I admit that in many cases, particularly where alkaline salts are present, as in the ordinary grades of superphosphates, simple ignition will remove organic matter and leave all the phosphoric acid in the tribasic or orthoform. But in some cases it will not—as, for instance, in the case of South Carolina superphosphate in Dr. White's interesting table. Now our uniform method must cover all cases likely to occur, and therefore some basic oxidising mixture must be used unless organic matter can be destroyed in the wet way. Magnesium nitrate is the best mixture of the kind, for it does not flux silica. Dr. White's experiments, however, prove, I think, that the organic matter can be destroyed or sufficiently altered for our purpose in the wet way, and as that method is much simpler I favour its adoption.

Prof. Stubbs remarked that by accident it was found in his laboratory that HNO_3 could supplant $Mg(NO_3)_2$ in analyses of complete fertilisers. The fertilisers, consisting of cotton-seed meal, acid phosphate, and kainite, were ignited with HNO_3 and analysed. Being afraid of error, they were duplicated with $Mg(NO_3)_2$, and the results found to agree.

After some further remarks the committee was directed to prepare the outline of a method to be used during the ensuing year.

By unanimous consent it was then resolved that the President should appoint a committee to consider the advisability of extending the scope of the Association, to report later on.

The President appointed Dr. White, chairman, Dr. Jenkins, and Dr. McMurtrie.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 16th, 1886.

Dr. Hugo Muller, F.R.S., President, in the Chair.

Messrs. A. Percy Hoskins and M. Hunter were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Henry Coates, Hedon House, 11, Archway Road, Highgate, N.; Thomas Cooksey, B.Sc., 284, Pentonville Road, N.; Hamilton Emmons, Mount Vernon Lodge, Leamington, U.S.A.; Herbert McKeon, 123, Lansdowne Place, Brighton; J. F. McArthur, Belgrave Crescent, Eccles; David Henry Nayel, 21, Tay Street, Dundee; Joseph De Carle Smith, Jun., Norwich; Lionel W. Stansell, 16, Hardy Street, Maidstone; D. A. Sutherland, Burntisland Oil Works, Burntisland, N.B.

The following were duly elected Fellows of the Society:—Messrs. Horace Edward Brothers; Francis J. H. Coutts; Tamemasa Haga; Henry John Hardy; Michitada Kawakita; Walter Leach; Stephen James Pentecost; Henry Joshua Phillips; P. Yeshwant Sheshadri; Tetsukichi Shimidzu; Joseph Stapleton; William Phillips Thompson; Hikorokuro Yoshida.

The following papers were read:—

116. "*Researches on the Constitution of 'Azo- and Diazo-derivatives.'* I. *Diazoamido-compounds.*" By R. Meldola, F.R.S., and F. W. Streatfeild.

In this paper the authors give the results of the application of the method described by them in a former communication (*Trans.*, 1886, 624) to determine the constitution of the diazoamido-compounds. The compound described in the previous paper, paradinitrodiazoamidobenzene, has the symmetrical formula

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(4)}{N_2}\cdot \underset{(4)}{NH}\cdot C_6H_4\cdot \underset{(1)}{NO_2},$$

and is consequently unsuited for the settlement of the question of intramolecular migration of the N_2-group. An unsymmetrical compound has therefore been prepared from paranitraniline and diazotised metanitraniline: it forms yellow needles melting at 211°, and furnishes on decomposition with chlorhydric acid a mixture of meta- and paranitranilines, and of meta- and paranitrochlorobenzenes. Its ethyl-derivative, prepared by the authors' method, melts at 148°, and gives on decomposition with chlorhydric acid a mixture of ethylmeta- and ethylparanitraniline, and of the two corresponding nitrochlorobenzenes. A method of identifying a mixture of meta- and paradiamines depending on the colour reaction on oxidation ("indamine" formation) is described in the paper. In order to throw some light upon the reaction which takes place when these compounds are decomposed by being heated with chlorhydric acid, experiments have been made by heating diazonitrobenzene chlorides with chlorhydric acid in the presence of similar and dissimilar nitranilines, but the products were found to be identical in all cases wih those of the corresponding diazoamido-compounds, so that it appears probable that these latter compounds are actually formed in the first instance. Metadinitrodiazoamidobenzene (Griess, *Liebig's Annalen*, 121, 272) has been prepared by the action of 1 mol. proportion of $NaNO_2$ upon two of metanitraniline dissolved in chlorhydric acid; it forms straw-coloured needles melting at 194°, and decomposes when heated with strong chlorhydric acid into metanitrochlorobenzene and metanitraniline. The ethyl-derivative forms opaque whitish-yellow needles melting at 119°; it is decomposed by chlorhydric acid into ethylmetanitraniline and metanitrochlorobenzene. The formulæ of these compounds are

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(3)}{N_2}\cdot \underset{(3)}{NH}\cdot C_6H_4\cdot \underset{(1)}{NO_2} \quad \text{and}$$

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(3)}{N_2}\cdot \underset{(3)}{N}(C_2H_5)\cdot C_6H_4\cdot \underset{(1)}{NO_2}.$$

The next part of the paper deals with the question of the identity of mixed diazoamido-compounds. In accordance with the results obtained by Griess (*Ber.*, 1874, 1619) and other observers, it has been proved that the compound obtained by the action of diazotised paranitraniline upon metanitraniline is identical with the above-mentioned compound formed by the action of diazotised metanitraniline upon paranitraniline. The two compounds have the same melting-point (211°), and give the same products on decomposition by chlorhydric acid; the same holds good with respect to their ethyl-derivatives (m. p. 148°). From these facts it follows that in the formation of this compound isomeric change must take place in one or the other mode of preparation, and in order to throw light upon this question, the authors have prepared for comparison the ethyl-derivatives resulting from the action of

the diazotised nitranilines upon the ethylnitranilines. Thus by combining diazotised metanitraniline with ethylparanitraniline, a compound of the formula

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(3)}{N}\cdot \underset{(4)}{N}(C_2H_5)\cdot C_6H_4\cdot \underset{(1)}{NO_2}$$

is obtained. This is *isomeric* with the ethyl-derivative (m. p. 148°) above described; it melts at 174—175°, and is decomposed by chlorhydric acid into metanitrochlorobenzene and ethylparanitraniline. On the other hand, by the action of diazotised paranitraniline upon ethylmetanitraniline, the compound

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(4)}{N_2}\cdot \underset{(3)}{N}(C_2H_5)\cdot C_6H_4\cdot \underset{(1)}{NO_2}$$

could not be obtained, but the product is apparently an amidoazo-compound forming orange-yellow needles melting at 187°. From diazotised paranitraniline and ethylparanitraniline, the compound

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(4)}{N_2}\cdot \underset{(4)}{N}(C_2H_5)\cdot C_6H_4\cdot \underset{(1)}{NO_2}$$

of m. p. 192°, described in a previous paper (*Trans.*, 1886, 630), is obtained. In a similar manner, diazotised metanitraniline acts upon ethylmetanitraniline with the formation of the diazoethylamido-compound of m. p. 119°, described in the present paper.

The further applicability of the authors' method has been tested by preparing benzyl-derivatives of the foregoing dinitrodiazoamido-compounds.

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(4)}{N_2}\cdot \underset{(4)}{N}(C_7H_7)\cdot C_6H_4\cdot \underset{(1)}{NO_2}$$

crystallises from benzene in small yellow needles melting at 190°; the corresponding modification 1 : 3 — 3 : 1 melts at 142, and the benzyl-derivative of the unsymmetrical dinitrodiazoamido-compound melts at 180°. The decomposition products of the benzyl-derivatives are analogous to those of the corresponding ethyl-derivatives. Summarising their results, the authors point out that the evidence obtained in the course of the present investigation shows a distinct tendency of the N_2-group to migrate to the para-position with respect to the other substituents: thus when metanitraniline is diazotised and combined with paranitraniline, the resulting compound has been proved to have the constitution

$$\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(4)}{N_2}\cdot \underset{(3)}{NH}\cdot C_6H_4\cdot \underset{(1)}{NO_2},$$

and not, as might have been expected on first consideration, $\underset{(1)}{NO_2}\cdot C_6H_4\cdot \underset{(3)}{N_2}\cdot \underset{(4)}{NH}\cdot C_6H_4\cdot \underset{(1)}{NO_2}$. This migration is possibly effected through the formation of an intermediate additive compound as suggested by Victor Meyer (*Ber.*, 1881, 2447), but the authors propose to submit this point to further investigation.

Discussion.

Mr. Friswell asked did Professor Meldola invariably use the sealed tube method: might not a less violent method be employed? He thought that probably what had been said of the easy decomposability of some of the amido-azo-compounds referred to might be extended to all such bodies.

Professor Meldola in reply, said that it was not always necessary to heat in a tube: mere boiling sufficed in many cases.

117. "*The Influence of Silicon on the Properties of Iron and Steel.*" Part I. By Thomas Turner, Assoc. R.S.M.

After referring to the work of previous observers in this direction, including Bessemer, Gautier, Mrázek, Pourcel, Riley, Snelus, and others, the author gives an account of experiments undertaken to determine the influence of silicon on the purest form of iron obtainable in considerable quantities. For these experiments metal was taken from the basic Bessemer vessel, at the end of the blow, and before any addition of manganese had been made. This metal had the following composition: C = 0·03, Si = 0·0098, S = 0·039, Mn = 0·06, P = 0·04. It was mixed in a red-hot clay crucible with varying small quantities of silicon pig, containing 10·3 per cent of silicon, the product being afterwards examined. The most important results are given in the table below.

Other specimens were prepared to which more silicon was added, but these broke in pieces in attempting to roll them. The last specimen in the above list is not comparable with the others, as in this case the silicon existed in the *oxidised* condition, and the material more closely resembled the original metal in its behaviour.

The author draws the following conclusions from his experiments. That the addition of silicon, in the form of silicon pig, to the purest iron obtainable in commerce tends to distinctly reduce its suitability for being rolled. With only a few hundredths per cent of silicon, the metal remains quiet in the mould. Red-shortness appears to increase with the amount of silicon, though the welding properties appear to be quite unaffected; the metal was tough when cold, with all proportions of silicon.

The limit of elasticity and tensile strength increase with addition of silicon, but the extension and the reduction of area are seriously diminished. The relative hardness is but slightly affected, and appears to be connected with the tenacity of the material.

With 0·4 of silicon and 0·21 of carbon a steel was obtained which was difficult to work hot, but could be hardened, and was very tough when cold. The author points out that these results would be considerably modified by the presence of larger quantities of carbon and manganese, such as are met with in practice.

Discussion.

In reply to a question by Dr. P. Frankland, Mr. Turner said that the high qualities of the sample which he had stated contained *oxidised* silicon (silica), were due not to the presence of this body, but to the absence of silicon.

The President asked if Mr. Turner could give any explanation of the boiling over, which he had referred to as occurring when the silicon-iron was added.

Mr. Turner said that the matter had been somewhat fully discussed elsewhere, and it was generally believed to be due to the evolution of gas which the iron had been able to retain in consequence of its containing silicon.

118. "*The Distribution of Nitrifying Organisms in the Soil.*" By R. Warington, F.R.S.

The result of 69 experiments with clay or loamy soil from various depths shows that the nitrifying agent is present almost without exception down to 3 feet from the surface; samples from below this depth did not always exhibit the power of causing nitrification, and none of the samples of soil taken 8 feet from the surface produced

Si per cent by analysis.	Limit of elasticity. Tons per sq. in.	Breaking load. Tons per sq. in.	Ratio limit to break.	Extension per cent on 10 inches.	Reduction of area per cent.	Relative hardness.
0·0098	13·01	21·80	0·597	27·7	77·0	18
0·02	13·08	19·95	0·656	17·6	40·3	16
0·035	15·69	23·07	0·680	16·3	31·8	17
0·039	16·42	23·28	0·704	18·2	37·7	17
0·08	16·72	23·77	0·704	24·2	44·9	20
0·117	18·00	28·05	0·642	15·6	26·8	21
0·13	18·37	25·68	0·715	18·8	41·9	20
0·027	17·75	21·75	0·861	26·0	67·4	15

nitrification. The nitrifying organism present in the subsoil is apparently in a feeble condition, nitrification starting much later in solutions seeded with subsoil than in those seeded with surface soil. Reasons are given for believing that in agriculture nitrification is practically confined to the surface soil. The nitrogenous matter present in the subsoil is, however, nitrifiable if exposed to favourable conditions.

DISCUSSION.

Mr. PERCY FRANKLAND remarked that it appeared desirable to use a nutritive material more constant in composition than urine in experiments on nitrification. He objected to the term "nitrifying organisms:" Heræus, in Berlin, having recently proved that there were a considerable number of organisms capable of inducing nitrification.

Mr. WARINGTON said that, however unfit urine might be for a certain class of experiments, as the object he had in view was to ascertain if nitrifying organisms were present, he maintained that it was sufficient to have an easily nitrifiable solution. The President had asked—were nitrifying organisms present in essentially siliceous soils? He had no experience except with Rothamsted soils, but he should say that they were if such soils were found to contain nitrates; moreover, Müntz had shown that if the organisms once became established in a bed, whatever its nature, it became more or less capable of effecting nitrification in suitable liquids passed through it.

119. "*Isomeric Change in the Phenol Series. The Action of Bromine on the Dibromonitrophenols.*" By A. R. LING.

The author's experiments have been conducted with the view of, if possible, obtaining some explanation of the isomeric change of dibromortho- into dibromoparanitrophenol by the action of bromine first observed by Armstrong (*Chem. Soc. J.*, 1875, 520). As products of the action of bromine on dibromorthonitrophenol he has obtained tetrabromoquinone, which is the chief product, together with bromo- and dibromoparanitrophenol and orthobromodinitrophenol; dibromoparanitrophenol and bromine yielding bromoparanitrophenol, orthobromodinitrophenol, and tetrabromoquinone.

It would seem that the formation of the bromanil involves the partial debromination of the dibromonitrophenol, the resulting bromorthonitrophenol then undergoing isomeric change: the bromoparanitrophenol thus produced is in part converted into bromodinitrophenol by the nitric acid resulting from the nitroxyl displaced in the formation of bromanil, and in part into dibromoparanitrophenol.

DISCUSSION.

Mr. GROVES asked if the author had tested his bromine for iodine; minute traces of this latter often had a most material influence: thus tribromophenol was readily converted into bromanil by means of bromine containing a little iodine, but not by pure bromine; and not a few other similar cases might be mentioned.

120. "*Some Azines.*" By FRANCIS R. JAPP, F.R.S., and COSMOS INNES BURTON, B.Sc.

The authors have endeavoured to ascertain whether ditolane-azotide, $C_{28}H_{20}N_2$, and diphenanthrylene-azotide, $C_{28}H_{16}N_2$ (*Trans.*, 1886, 826 and 843), belong to the class of the ketines or to that of the azines. They find that no ditolane-azotide is formed when benzilmonohydroxim is treated with tin and hydrochloric acid, contrary to what might be expected to occur if the azotide were a ketine.

They further show that there is a close analogy between diphenanthrylene-azotide and Witt's α-β-naphthazine (*Ber.*, 19, 2794), and they have succeeded in synthesising the latter compound by heating β-naphthaquinone with ammonium acetate—a reaction which exactly corresponds with that in which diphenanthrylene-azotide is obtained from phenanthraquinone (*Trans.*, 1886, 829, foot-note) These analogies, together with the fact that ditolane azotide may be transformed into diphenanthrylene-azotide (*Trans.*, 1886, 843), lead them to regard these compounds as azines.

CORRESPONDENCE.

AN EXAMINATION PUZZLE.

To the Editor of the Chemical News.

SIR,—It is obvious that A.X. derives his acquaintance of analysis chiefly from books and not from practical experience, or he would not expect to *precipitate* the ammonia by means of $PtCl_4$. He evidently does not understand the question, which means that potassium is absent. I should advise him to procure Clowes's "Practical Chemistry," and work according to the directions there given for the analysis of mixtures, and the next time he buys sodium silicate to ask for "soluble glass." I will not waste any more of your valuable space.—I am, &c.,

A.P.S.

["A. P. S." is mistaken in assuming that "A. X." is inexperienced. Were we at liberty to say who "A. X." is, he would be recognised as one of the most accurate and skilful chemists of the day, and the author of one of the leading books on Analysis.—ED. *C. N.*]

CRYSTALS IN WHISKY.

To the Editor of the Chemical News.

SIR,—A closely felted mass of fine silky needles was brought to me some time since as having been discovered in a bottle of whisky. Analysis proved them to be Epsom salts, but in a form which was new to me.

I find that such a mass may be produced by mixing a solution of the salt with a proper proportion of alcohol, showing that the salt had been added to the whisky in aqueous solution.

A very pretty experiment on crystallisation may be made by adding methylated alcohol to a moderately strong solution of magnesium sulphate till a slight permanent turbidity appears, and immersing the vessel in cold water; stellate tufts of crystals soon separate, having about the same specific gravity as the liquid, in which they remain suspended, and rapidly grow till the whole liquid has become a mass of matted needles. If the turbid solution, before crystallisation commences, is poured into a watch-glass and examined under the microscope through an inch objective, the effect is remarkably beautiful.

I have determined the water in the fine light silky needles and find them to be $MgSO_4 \cdot 7H_2O$.—I am, &c.

PRACTICAL CHEMIST.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 23, December 6, 1886.

Action of Manganese on the Phosphorescent Power of Calcium Carbonate.—Edmond Becquerel.—Iceland spar is one of the first substances which presented to the author a luminous appearance in the phosphoroscope after the previous action of luminous rays. The colour of the phosphorescent light is orange, but there are very

great differences in the intensity of the light emitted by different specimens. The presence of foreign matter can very much modify the phosphorescent power of certain bodies, and it was therefore important to examine if the differences of luminous effects given by various specimens of calc spar might not be due to the presence of a minute trace of foreign matter mixed or combined with the spathic calcium carbonate. The most luminous crystals of spar, orange in the phosphoroscope, contain a moderately high proportion of manganese, probably in the state of carbonate; there were scarcely any traces of iron carbonate. Fragments of calc-spar, still very luminous, contained manganese in less proportions, and less brilliant specimens contained only very little, or none at all if examined by ordinary analytical methods. Synthetic experiments lead to the same conclusion as the analysis of the natural crystals. These results show distinctly the action of manganese. Calcium carbonate obtained by dissolving fragments of Iceland spar in pure hydrochloric acid, even after several successive precipitations with ammonium carbonate, always led to the preparation of sulphides having an orange phosphorescence, whilst when the raw material used is arragonite the phosphorescence is always of a bright green. It is probable that the orange phosphorescence is either due to a double manganese-calcium carbonate, or to the fact that the presence of manganese gives to the calcareous compound a peculiar molecular arrangement, whence results a phosphorescent power more or less energetic, and a luminous emission of a given colour. This substance would then merely exalt the intensity of the light emitted by the spar. The author has shown that the crystalline form may interfere in these luminous reactions, since all the specimens of arragonite studied in the phosphoroscope emit a green instead of an orange light. Other bodies besides manganese can produce, in calcium sulphides, profound modifications in the intensity and the quality of the light emitted; such are lithium carbonate, bismuth, antimony, various sulphides, &c.

Composition of Cider.—G. Lechartier.—Pure ciders examined by the author contained 5 to 6 per cent of alcohol, 30 per cent of extract, and 2·8 per cent of ash.

Red Fluorescence of Alumina.—Lecoq de Boisbaudran.—Alumina, ignited and submitted to the effluve in a vacuum, did not give a trace of red fluorescence. This fluorescence was elicited by the presence of a trace of chromium sesquioxide.

Exploder Verifier of Quantity and Tension.—L. de Place and Bassée-Crosse.—This memoir cannot be intelligibly reproduced without the three accompanying diagrams.

Calorimetric Researches on Specific Heats and Changes of State at High Temperatures.—M. Pionchon.—The study of silver up to a temperature 200° above its melting-point gives a novel instance of the almost absolute identity of metals before and after fusion. In the three magnetic metals the variation of the specific heat reveals the existence of allotropic modifications. These changes of state take place in iron between 660° and 720°, and again about 1050°; for nickel, between 220° and 400°, and for cobalt about 900°. The law of Dulong and Petit cannot have the character of absolute strictness formerly ascribed to it.

Vapour Tensions of Solutions made in Ether.—Em. Raoult.—If we dissolve 1 mol. of any compound in 100 grms. of ether we diminish the vapour tension of this liquid by a constant fraction of its normal value; this fraction is 0·71 for all temperatures between 0° and 25°.

Volatilisation of Dissolved Bodies in the Evaporation of their Solvent.—P. Marguerite-Delacharlonny.—Liquid particles, holding salts in solution, are carried away with the vapour not merely at a boiling heat, but even at the ordinary temperature. The same process takes place from acid salts in the solid state, such as ferrous sulphate.

Researches on Bimetallic Phosphates and allied Salts, and on their Transformations.—A. Joly.—Many phosphates insoluble or sparingly soluble in water, may be obtained by double decomposition between a solution of disodic phosphate and a metallic solution. According to the nature of the metal the final product of the reaction is a trimetallic or a dimetallic phosphate. Thus, where the metallic solution is silver nitrate, we have at once a yellow amorphous precipitate of triargentic phosphate, and the liquid contains free acid. In the case of salts of calcium, strontium, barium, manganese, &c., the final product is a bimetallic crystalline phosphate. At the moment of mixing the two liquids we observe the formation of a gelatinous precipitate differing little in composition, if the solutions are sufficiently dilute from a trimetallic phosphate. The liquid is then acid to litmus, neutral to methyl orange, and contains a mono-metallic phosphate. The transformation of the initial gelatinous precipitate into a crystalline product results from an ulterior chemical action between the precipitate and the liquid.

Saturation of Normal Arsenic Acid by Magnesia and Formation of Ammonium-Magnesium Phosphate.—Ch. Blarez.—The author examines the monomagnesium, bi- and tri-magnesium arseniates, in which the direct neutralisation-heats of a mol. of arsenic acid by magnesia, are, for the first equivalent, 14·866 calories, for the second 11·464, and for the the third, 2·03.

Phenomena produced during the Heating and Cooling of Cast-Steel.—M. Osmond.—In melted iron containing 0·16 per cent of carbon, the author finds below 800° only a slight perturbation during cooling, about 749°. The cooling of cast-iron presents altogether three retardations; 1, between 863° and 820°, with a maximum between 845° and 839°; 2, between 775° and 736°, with its maximum between 763° and 749°; and 3, between 693° and 669°.

Influence of Silicon on the Condition of Carbon in Cast-Irons.— F. Guatier.— The author describes an alloy, ferrosilicon, containing at least 2 per cent of the latter element, which is grey, of a very compact grain, very fluid, and in every respect suitable for casting.

Water of Combination of Alums.—E. J. Maumené. — Ordinary potassium-aluminium alum contains 28·73 equiv. of water. If allowed to dry over sulphuric acid for 166 days it lost only 3·5 water, so that the assumed standard of 24 was not reached.

Neutralisation-Heat of Meconic and Mellitic Acids —H. Gal and E. Werner.—The numbers furnished by meconic acid are lower than the corresponding figures for mellitic acid. This result might be foreseen, as meconic acid is an alcohol acid. The heat liberated in neutralisation diminishes as this process advances.

Moniteur Scientifique, Quesneville.
3rd Series, Vol. xvi., September, 1886.

The Industrial Preparation of Aluminium. — Dr. Mehner.—This paper is devoted to the process of Cowles Brothers, who reduce aluminium from its oxides by means of the electric arc. The demi-molecule of aluminium requires for its reduction 185,000 calories, which is more than carbon can furnish.

MEETINGS FOR THE WEEK.

MONDAY, 27th.—London Institution, 5.
TUESDAY, 28th.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.
THURSDAY, 30th.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.
—— London Institution, 6.
SATURDAY, Jan. 1st.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.

THE CHEMICAL NEWS.

Vol. LIV. No. 1414.

THE ESSENITAL OILS: A STUDY IN OPTICAL CHEMISTRY.*

By J. H. GLADSTONE, Ph.D., F.R.S.

The optical properties of the essential oils which are the subject of study on this occasion are their specific refractive and specific dispersive energy. These depend mainly upon their atomic constitution, while the power of rotating rays of light seems to depend rather upon the arrangement of the molecules.

The specific refractive energy is the refractive index minus unity, divided by the density. The specific dispersive energy is the difference between the refractive energy for two different parts of the spectrum, such as the solar lines A and H; or, more simply, the refractive index for H, minus that of A, divided by the density. The refractive energy multiplied by the atomic weight is termed the refraction equivalent. The dispersion equivalent is arrived at in the same way from the dispersive energy.

The data employed are given in the following Table, the first column of which gives the name of the substance, the second its molecular composition, the third and fourth columns the refraction and dispersion equivalents as determined by experiment. The refraction equivalent is calculated for the solar line A.

Substance.	Molecular constitution.	By experiment.		Normal calculation.		Theoretical value.	
		Ref. eq.	Disp. eq.	Ref. eq.	Disp. eq.	Ref. eq.	Disp. eq.
Terpenes	$C_{10}H_{16}$	73·0	4·0	70·8	3·2	73·0	4·0
Camphene†	,,	71·9	3·7	70·8	3·2	73·0	3·7
Citrenes	,,	75·0	4·6	70·8	3·2	75·2	4·5
Isoprene†	C_5H_8	40·3	3·2	35·4	1·6	39·6	3·2
Terpene hydrochlorate†	$C_{10}H_{18}Cl_2$	92·2	4·3	93·2	4·3	—	—
Terpene hydrate‡	$C_{10}H_{22}O_3$	87·4	4·1	88·2	4·0	—	—
Camphor	$C_{10}H_{16}O$	73·5	3·4	74·2	3·4	—	—
Terpinol†	$C_{10}H_{18}O$	79·0	4·2	76·2	3·4	78·4	4·2
Eugenic acid	$C_{10}H_{12}O_2$	81·4	7·2	71·8	3·3	80·6	6·5
Camphoric acid	$C_{10}H_{16}O_4$	82·8	3·8	83·2	3·8	—	—

The law is now generally recognised that the refraction equivalent of a compound body is the sum of the refraction equivalents of its constituents, with certain limitations; and the same law seems to hold good in regard to dispersion equivalents. Now the refraction equivalent of carbon is 5·0, of hydrogen is 1·3, of chlorine 9·9, and of oxygen 2·8 or 3·4 (according to whether it is hydroxylic or aldehydic). Similarly the dispersion equivalent of carbon has been estimated by me at 0·25, of hydrogen at 0·045, of chlorine at 0·51, and of oxygen at 0·10 or 0·18.‡ Reckoning the value of the substances in the above Table by these numbers, we arrive at the figures given in columns 5 and 6 under the head of "Normal Calculation." It is at once apparent that while some of these are fairly coincident with the figures deduced from experiment, others are considerably divergent. This is explained by the fact that wherever there is a pair of doubly-linked carbon atoms the refraction equivalent is increased by about 2·2, and the dispersion equivalent by about 0·5 in such substances as the olefines, or by about 0·8 in the aromatic group of bodies.

Bearing these figures in view, we arrive at the following conclusions from the optical data:—

1. That terpene hydrochlorate, terpene hydrate, camphor, and camphoric acid are saturated bodies. There are chemical grounds for the same conclusion in regard to each of these substances.
2. That terpene, notwithstanding the small amount of hydrogen, is nearly saturated, containing only one pair of doubly-linked carbon atoms. The theoretical equivalents will then be as given in the last columns, headed "Theoretical Value."
3. That isoprene, though it has only half the molecular formula, contains two pairs of doubly-linked carbon atoms, as shown similarly in the last columns.
4. That terpinol contains one pair of doubly-linked carbon atoms.

While these conclusions may be considered as fairly well established, there are others which must still be considered as speculative:—

1st. That there is a difference in chemical structure between terpene and camphene, indicated by the fact that, while both contain one pair of carbon atoms doubly-linked, the double linking in the camphene is analogous to that of the olefines rather than to that of the aromatic bodies. The theoretical figures on this supposition are given in the last columns.

2nd. That the citrenes differ from the terpenes by containing a second pair of doubly-linked carbon atoms, and that the double-linking of this second pair is also analogous to that of the olefines.

3rd. That eugenic acid contains four pairs of doubly-linked carbon atoms, the theoretical figures being even then below those derived from observation.

* Communicated to the British Association, Birmingham Meeting, Section B.

† Prepared by Prof. Tilden.

‡ See my papers on "Essential Oils, No. III., their Specific Refractive and Dispersive Energy" (*Journ. Chem. Soc.*, 1886, p. 609); and "Sur les Equivalents de Refraction et de Dispersion" (*Arch. des Sciences Physiques et Naturelles*, September and October, 1886).

ON THE COMPOSITION OF HYDRATED SALTS.

By E. MAUMENÉ.

To the Editor of the Chemical News.

Sir,

In the Chemical News of December 3rd I notice a paper by Messrs. Spencer U. Pickering and P. Sanford, in which these gentlemen profess to explain in a very simple manner (!) the results published some time back by me.

I have the honour of sending you an answer to the criticisms of my two honourable *confrères*. Pardon me for saying that the criticism is not worthy of the subject.

I trust—not from any feelings of *amour propre*, but solely on account of the importance of the subject, which

cannot be over-estimated—that you will be able to find space for my reply.

I remain, &c.,

E. Maumené.

91, Avenue de Villiers, Paris.

If this question appeared to chemists to be as important as it really is, we should spare no effort to solve it by experiments as accurate as possible, bearing in mind, at the same time, the precept "Experientia fallax; judicium difficile."

Several chemists, and notably those in England, have recently examined this question with very great attention. Messrs. W. J. Nicol, W. A. Tilden, and others, have brought forward ideas, bearing more or less directly on the subject, quite recently. Messrs. S. U. Pickering and P. Sanford have advanced certain experimental studies as a help to a solution, which should be energetically upheld or opposed.

The best help is undoubtedly the General Theory which I respectfully brought before the notice of chemists almost twenty-three years ago, their indifference to which becomes daily more and more astonishing to me.

Messrs. S. U. Pickering and P. Sanford have just published (Chemical News, vol. liv., p. 277) several experiments professing to disprove the Theory.

The authors have actually found that one fact suffices to upset "in reason" a General Theory whose generality is so complete that it ought to require a large number of facts, but I hope to show very easily that the efforts of the critics have never been so far from attaining their ends; never, in trusting to one reason only, has the necessity for many and strong reasons been so blindly overlooked.

The Maumené Theory is of such universal application that it embraces chemistry in its entirety, without any exception,—lighting it with such a clear light that one must be most completely enveloped in the clouds of *routine* not to be enlightened by it.

All chemists, and especially English chemists, have recently had a startling proof of its applications, thanks to which I have been able to show that the General Theory enables us to explain *à priori*, and in all its details, the complicated (and previously unintelligible) chemical reactions of the pyrolysis of chlorate of potash.

It has been known, from the time of Terrellas, that this pyrolysis has a first phase which produces a salt whose acid contains more oxygen than chloric acid; it is perchlorate of potash which is produced.

In spite of numerous experiments, by which the truth was gradually coming to light, it was still admitted, and all the text-books taught as an *explanation* (!) the simple formula—

$$2ClO_5KO = ClK + ClO_7KO + O_4.$$

Instead of this classic formula, Teed—without knowing the General Theory, but having recognised by laborious experiments how far the above-mentioned was from the truth—took the trouble to establish the true formula by means of very accurately graduated pyrolyses. I will not here reproduce it, since it has already been given in the Chemical News only a year ago, with all necessary details.

I then made another appeal to chemists, and again brought under their notice the equation required by the General Theory, and published by me thirteen years before in *Les Mondes*. Its identity with the indisputable experimental equation found by Teed was most complete evidence, and ought by itself to have opened everybody's eyes. Messrs. Pickering and Sanford knew of this work, for they quote, among the examples of the General Theory which they try to combat, peroxide of potassium K_8O_{39} (or $KO_{4\cdot875}$); peroxide of sodium Na_8O_{23} (or $NaO_{2\cdot875}$), which I mentioned in the memoir relating to the chlorate.

They were also cognisant of my memoir on the alkaline hydrates, for they quote—

Hydrate of potash, $(KO)_9(HO)_{47}$,
Hydrate of soda, $(NaO)_9(HO)_{23}$.

They had therefore full knowledge of the two series of bodies, of which I was able to calculate the *true* formulæ *à priori*. I say *true*, because these formulæ have been established by different chemists and by myself by means of experiments of the greatest possible exactitude. The formulæ have an air of greatness due to their *simplicity*: $KO_{4\cdot875}$, which does not appear "naturally to find an easy welcome among chemists" (why? my two *confrères* ought certainly to have said), is of extreme simplicity. This formula represents what we can imagine to be of the greatest simplicity, viz., a combination of equal weights,—

$$K_8 = 39\times8;\ O_{39} = 8\times39;$$

weights which are absolutely equal. It is just the same with regard to—

Na_8O_{23},
$(KO)_9(HO)_{47}$,
$(NaO)_9(HO)_{31}$,
$(BaO)_9(HO)_{76\cdot5}$,

and all analogous or possible compounds *in all chemical reactions without exception*.

If we refer to Gay-Lussac and to Thenard, we find KO_3 and NaO_3 for the peroxides; and if to Vernon Harcourt, we find KO_4 and NaO_2; but according to some experiments of my own, not yet published, I affirm that $KO_{4\cdot875}$ and $NaO_{2\cdot875}$ are the true formulæ of these peroxides.

As to the hydrates, $(KO)_9(HO)_{47}$ was given by Ph. Walter in the year 1836, twenty-eight years before the first publication of the General Theory. This formula was confirmed by my experiments in 1884, by the aid of two new methods:—

1. Desiccation of the hydrate by means of a hydrate of the same oxide, less rich in water: melted potash, &c.
2. Desiccation of the crystals at about 105° C., in a very dry current of air, until the weight remains unchanged, for several hours, or even days.

The General Theory has been proved by many other facts no less indisputable, and to doubt it—which of course is quite permissible—cannot lead to its rejection without having very serious proofs, as thoroughly reliable as the experimental facts whose existence I have just recalled.

All compound bodies are in the general case in which the following holds good:—

From a chloride, CaCl, we get $(CaCl)_9(HO)_{55\cdot5}$,
or $CaCl\ (HO)_{6\cdot17}$.

From a sulphate, SO_3MgO, we get $(SO_3MgO)_9(HO)_{60}$,
or $SO_3MgO\ (HO)_{6\cdot67}$.

From an alum, $\left\{\begin{matrix}(SO_3)_3Al_2O_3\\SO_3\ KO\end{matrix}\right\}$ we get—

$$\left\{\begin{matrix}(SO_3)_3Al_2O_3\\SO_3\ KO\end{matrix}\right\}_9 (HO)_{256\cdot5},$$

or alum, $(HO)_{28\cdot73}$.

We admit in the case of—

CaCl,	6·000 HO,	and not 6·17.
SO_3MgO,	7·000 HO,	,, 6·67.
Alum,	24·000 HO,	,, 28·73.

But who can sustain "in reason" the truth of these figures, *apparently so simple*, but in reality so complex, as to be unknown; and what chemist is able to tell us *one word* about the combination of—

CaCl	with 6 HO (really 6·17),
SO_3MgO	,, 7 HO (really 6·67),
or alum	,, 24 HO (really 28·73)?

With regard to this latter figure, which has been most accurately found by my recent experiments on pure octahedric and pure cubic alum, dried by my method,—that is to say, by calcined alum, under the same shade,—I

have just added the last proof that crystallised alum kept under a shade with sulphuric acid loses its water very rapidly and very regularly, without for one moment remaining in the state corresponding to 24HO.

I am forced to repeat myself:—The following examples, which are in no way specially selected, are taken from the most diverse classes of bodies,—peroxides, sulphates, hydrates, hydrated protoxides, hydrated chlorides, double sulphates, hydrated alums, &c. They are found in the whole range of chemistry without exception, because *the law of equal weights* is a *true* law, founded on simple calculation and free from all hypothesis.

To discredit "in reason" so beautiful a law, I ask all chemists, and above all Messrs. Pickering and Sanford, Have their experiments the slightest value? That crystals of NaCl retain a few thousandths of water at 100° I am perfectly willing to admit, but at 200° I deny it absolutely (according to some experiments made by me with extreme care in the year 1841). And further, I ask, Is it by adopting such illogical conditions (using fragments of a notable size, where these gentlemen explain themselves that the water was retained between the faces of the crystals),—is it by working in such a manner as to purposely cause mistakes, that anyone can decide the very grave question of the law of *equal weights*?

What it is necessary to prove and explain is that KO forms with HO, $(KO)_9(HO)_{47}$, &c.

These truths are proved by the General Theory, because all that results from a general law is proved. Does this proof want further experimental verification? Far from it; it agrees entirely with experience, for the more carefully the experiments are made the more closely they agree with the theoretic previsions.

Can Messrs. Pickering and Sanford deny one single result which has been predicted, explained, and proved by the General Theory? I say emphatically *No*, and I shall never be contradicted by experiments which serve to solve the great problem which is the basis of all chemistry.

STUDIES ON THE BEHAVIOUR OF THE PTOMAINES IN CHEMICO-LEGAL INVESTIGATIONS.

By K. TAMBA.

Morphine, in admixture with the ptomaines obtained by the author, can be recognised by the sugar and sulphuric reaction, the violet colour coming out distinctly; also with strong sulphuric acid on evaporation in the water-bath, and subsequent addition of hydrochloric acid, when a violet colour appears. In presence of ptomaines, iodic acid is reduced by morphine only when the ptomaines are present in mere traces. The other reactions of morphine are useless in presence of ptomaines.

The characteristic reaction of strychnine with potassium dichromate and sulphuric acid is not interfered with by ptomaines.

The nitric acid and the mercurous nitrate reactions are not affected by ptomaines, but that with nitric acid and sulphuric acid is interfered with.

With atropine the presence of ptomaines does not affect the reaction with nitric acid and alcoholic potassa, but it interferes with the odour characteristic of the action of sulphuric acid upon atropeine.

The blood-red colouration of narceine with strong sulphuric acid does not appear in presence of ptomaines.

Fuming nitric acid colours the ptomaines a reddish yellow, but does not mask the characteristic violet colour of colchicine, if present.

Codeine in presence of ptomaines gives its reactions with sulphuric acid and with a mixture of sulphuric and nitric acids, but Frœhde's reagent is in this case untrustworthy.

Phosphoric and strong sulphuric acids in presence of ptomaines are useless reagents for aconitine (*i.e.*, the commercial qualities).

The sulphuric acid and ammonium bromide reaction for digitaline fails in presence of ptomaines.

The reactions for picrotoxine are interfered with by ptomaines, and delphinine cannot be recognised in their presence.

From further experiments the author concludes that the Stas-Otto method of extraction must always remain the first step. To be recommended is heating or distilling the acid extracts (after removal of the alcohol) with magnesia or lime hydrate to separate amines and volatile ptomaines. Basic lead acetate and recently precipitated lead hydroxide are well adapted for removing colouring-matters and other impurities from liquids occurring in judicial investigations, as they do not keep back any alkaloids. The use of powdered gypsum for drying up solutions for extraction with ether or chloroform does good service, as also the application of these general solvents for twelve or twenty-four hours at a boiling heat.

The ptomaines formed in the putrefaction of the liver and of masses of flesh can be almost completely separated from the alkaloids by prolonged extraction of the acidulated material with boiling ether, the ptomaines passing into solution. Ethereal solutions of alkaloids mixed with ptomaines can be separated by the addition of a saturated solution of oxalic acid in ether. On standing, the alkaloid is deposited as a crystalline oxalate, whilst the ptomaines remain in solution.—*Zeitschr. f. Anal. Chem.*, vol. xxv., p. 609.

NEW METHOD FOR THE QUANTITATIVE DETERMINATION OF SULPHUR.

By M. VON KLOBULOW.

The object of the process is the volumetric determination of the total quantity of sulphur in all such of its compounds as are capable of being decomposed by acids. The products of such decompositions are hydrogen sulphide, sulphurous acid, free sulphur, and, in certain special cases, sulphuric acid. The author finds that, under certain conditions, nascent hydrogen converts not only sulphuric acid, but even the sulphur liberated from some compounds quantitatively into hydrogen sulphide. Hence the principle of the method consists in the reduction of the decomposition-products of sulphur compounds by acids (always excepting sulphuric acid, which, if present, is determined in the ordinary manner) to hydrogen sulphide and its subsequent iodometric determination.

The conditions of the reaction are as follows:—

Sulphurous acid in solutions of a moderate degree of concentration is completely converted into hydrogen sulphide by nascent hydrogen at ordinary temperatures, or, better still, at a gentle heat, if air be excluded, and without any formation of sulphuric acid. The sulphur liberated on the decomposition of some sulphur compounds by dilute mineral acids is completely reduced to hydrogen sulphide in solutions of a moderate concentration, air being excluded, either at ordinary temperatures or preferably with slight refrigeration. In the author's method the sulphur compound in question is decomposed in a closed vessel in presence of zinc and hydrochloric acid. The sulphuric acid, which in some cases appears as a final product of the decomposition, remains in the apparatus, and is determined as barium sulphate along with any sulphuric acid pre-existing in the original sample; whilst the hydrogen sulphide, which always appears as the other final product, passes into suitable absorption-apparatus, filled with a titrated solution of iodine, the excess of which is titrated back after the operation. The apparatus used is as follows:—A capacious flask, holding about 500 c.c., in which the decom-

position of the substance is effected, is connected, on the one hand, with the absorption-apparatus, and on the other (by means of a tube reaching to the bottom) with a hydrogen-apparatus; a ball-funnel, fitted with a glass cock, permits of the introduction of the hydrochloric acid required for decomposition.

The absorption-apparatus consists of the following parts, arranged in the order mentioned:—A large flask in which the gas-delivery pipe from the decomposition flask reaches to the bottom, and which contains the bulk of the standard solution of iodine; a Liebig's potash-apparatus, also filled with standard iodine solution; a second potash-apparatus, filled with a solution of potassium iodide, in which any iodine vapour carried along from the former apparatus is absorbed. In carrying out the process a quantity of granulated zinc, free from sulphur and arsenic, is introduced into the decomposition flask along with the weighed substance in question or its solution, and diluted with a sufficiency of water. The flask is then closed, connected with the other pieces of apparatus, and hydrogen is passed in for about ten minutes to expel air, when the decomposition may be commenced. The zinc must be in excess, though too large a quantity makes the operation more tedious. The following cases must be distinguished:—

1. If there appears as decomposition product, besides hydrogen sulphide, free sulphur,—either alone or along with sulphurous acid,—the decomposition flask is placed either in a dish of cold water or in a vessel with a continual flow of water, and the decomposition is conducted as slowly as possible. Supposing the solution to be originally clear, it becomes milky in consequence of the liberation of sulphur, but this turbidity gradually disappears, and the liquid grows clear again. When the process has reached this stage, which occurs in twenty to twenty-five minutes, the cooling arrangement is removed, more acid is added, and the solution of the residual zinc is promoted by a gentle heat. When the zinc is completely dissolved the flask is heated for a time to 70° to 80°. The current of hydrogen (which does not need to be very strong as long as zinc is still present) is reinforced, and the liquid in the decomposition flask is thus kept in brisk motion, which, on the one hand, hastens the removal of the last traces of hydrogen sulphide from the liquid, and prevents a reflux of the absorptive liquid into the decomposition flask as the latter cools.

2. If, in the decomposition of the substance in question, there appears no sulphur, but merely sulphurous acid and hydrogen sulphide, any refrigeration is superfluous; the decomposition is begun at the ordinary temperature, and afterwards quickened by a gentle heat. In other respects the process is conducted as in Case 1.

Before breaking off the experiment it is well to ascertain, by means of lead-paper, if the sulphuretted hydrogen has been entirely removed from the flask. This test is best applied at the joint between the gas delivery-tube and the first absorption-apparatus.

The duration of the entire process is 1½ to 2 hours; after its completion the absorbent vessels are emptied into one common vessel, and the excess of the iodine solution is titrated back with sodium thiosulphate. The liquid in the decomposition flask contains all the sulphuric acid which has been formed during the decomposition, as well as that—if any—pre-existing in the substance. Its determination is effected in the ordinary manner. The solutions used are decinormal iodine and sodium thiosulphate standardised to each other. The hydrochloric acid used is of the strength 1 : 1.—*Zeitsch. f. Anal. Chem.*, vol. xxv., p. 555.

Agricultural Value of Reverted Phosphate.—Jules Joffre.—The author's experiments prove that precipitated phosphate, insoluble mineral phosphate, and reverted phosphate are all strikingly inferior in their efficacy to soluble phosphate.—*Moniteur Scientifique.*

NICKEL AS A MATERIAL FOR DISHES AND CRUCIBLES.

By J. ALFRED WANKLYN.

It is well known that pure nickel is one of the toughest of all the metals and that it fuses only at very high temperatures. It has a very fine grain, takes a high polish, and is very compact and unalterable.

These qualities have led to its being employed for crucibles and evaporating dishes. I have recently had some of these vessels in my laboratory.

The following notes may possibly be of interest to the readers of the Chemical News.

A small crucible of pure nickel, purchased at Becker's, in Maiden Lane, for 2s. 8d., weighed 17·6025 grammes. It was then ignited strongly by means of a large Bunsen burner, and when cold was re-weighed. Not the slightest alteration in weight could be detected.

A larger crucible, weighing 39·666 grammes, was also experimented upon, and exhibited a like constancy of weight on ignition.

For many purposes crucibles of pure nickel are quite as serviceable as platinum crucibles, and they are much cheaper, costing only about one-tenth as much as platinum.

They stand the action of alkalies remarkably well—there was no alteration in the weight of the crucible after caustic potash had been fused in it.

Hydrochloric acid in the cold, whether dilute or concentrated, may be used to clean out these crucibles and no alteration in weight is the result.

Cold oil of vitriol is likewise without action; but concentrated nitric acid attacks them, causing rapid loss of weight.

My experience leads me especially to recommend nickel dishes as suitable vessels for taking water-residues and milk-solids, and indeed for these purposes I do not think that nickel is at all inferior to platinum.

REPORT OF THE COMMITTEE *

APPOINTED FOR THE PURPOSE OF INVESTIGATING

ISOMERIC NAPHTHALENE DERIVATIVES.†

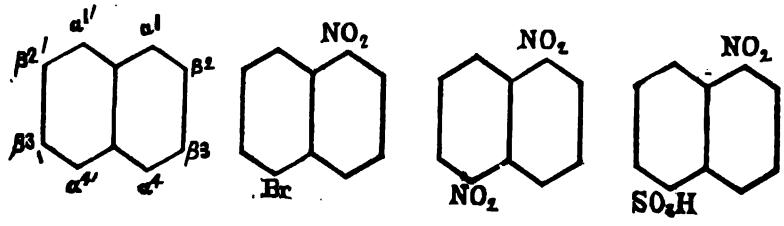
The study of isomeric naphthalene derivatives acquires importance from a variety of considerations, notably from the very close relationship of naphthalene to benzene, which finds expression in the use of a simple hexagon to represent the latter hydrocarbon, the first mentioned being symbolised by a double hexagon formed of two benzene hexagons joined so that one side is common to both.

In the case of benzene there are but three possible isomeric di-derivaties, according to the received theory of the constitution of this hydrocarbon; the formation of these di-derivatives is governed by certain very simple "laws," the first of which may conveniently be termed the *para*-law, the second the *meta*-law: *i.e.*, mono-derivatives containing a hydrocarbon radicle, one of the halogens, NH_2, or OH invariably yield as *chief* product a para-di-derivative together with the isomeric ortho-di-derivative, the meta-di-derivative being formed, if at all, to but a small extent; whereas mono-derivatives containing NO_2, SO_3H, or COOH yield as chief product the *meta*-di-derivative, the para- and ortho-derivatives being formed in relatively small amount.

Instead of three, naphthalene may give rise to ten isomeric di-derivatives; it might therefore be expected that the laws of substitution for naphthalene would be proportionally less simple than for benzene; thus far,

* Consisting of Professors Tilden and Armstrong (Secretary).
† British Association, Birmingham Meeting, 1886.

however, this has not been found to be the case, and many of the di-derivatives are to be prepared only by indirect methods. The para-law obtains equally in the case of naphthalene, being applicable to mono-derivatives analogous to those which in the benzene series obey the para-law; but an interesting modification of the meta-law, exemplified by the behaviour of nitronaphthalene to bromine, nitric acid, and sulphuric acid, is to be noted: nitrobenzene under such circumstances would yield chiefly the meta-derivative, but in the case of nitronaphthalene the attack becomes shifted to the other nucleus, an α-α-derivative being formed as represented by the formulæ:—



It would appear from our knowledge of the naphthalene derivatives generally that, as a rule, the α-hydrogen atoms (see figure) are those which become displaced, and that the β-atoms are affected only under somewhat exceptional conditions—as in the formation of β-sulphonic acids at high temperatures in presence of an excess of sulphuric acid—and when an amidogen or hydroxyl group is present. Hence the behaviour of nitronaphthalene above referred to—the absence of similarity in the behaviour in the corresponding nitro derivatives of naphthalene and benzene—is not improbably due to the existence, in the case of naphthalene, of a higher law, which it may be permitted to term the "*alpha*-law."

As naphthalene-β-sulphonic acid is the only β-derivative obtainable directly from naphthalene, it appeared to be specially important to study the behaviour of the sulphonic derivatives in order to throw light on the formation of the β-monosulphonic acid; and it was to be expected that their investigation would furnish results of value in determining the laws of substitution in the naphthalene series: moreover the ease with which the sulphonic radicle may be removed by hydrolysis renders the sulphonic derivatives especially suitable subjects of study.

It will suffice to indicate briefly the character of the results hitherto obtained, reserving a full account for one of the chemical journals.

The action of sulphuric acid in excess on naphthalene at a temperature of 160°—180° has been studied by Ebert and Merz, who isolated two distinct acids—an α- and a *β-disulphonic acid*; Armstrong and Graham (*Chem. Soc. Trans.*, 1881, p. 133; *Berichte*, 1882, p. 204) on re-examining the product obtained evidence of the presence of other disulphonic acids, but after numerous trials the attempt to separate these was for the time abandoned, and attention directed to the preparation of disulphonic acids hy other methods less likely to give rise to secondary changes, such as readily occur on heating in presence of sulphuric acid. The result has been to establish the existence of two acids isomeric with the α- and β-acid of Ebert and Merz.

γ-Naphthalenedisulphonic Acid.—This appears to be the sole product of the action of chlorosulphonic acid, $ClSO_3H$, on naphthalene in accordance with the equation: $C_{10}H_8 + 2SO_3HCl = C_{10}H_6(SO_3H)_2 + 2HCl$. On distilling its chloride (m. p. 184°) with phosphorus pentachloride, γ-dichloronaphthalene is produced: therefore it may be concluded that γ-naphthalenedisulphonic acid is an α-α-derivative of the same constitution as the nitronaphthalene derivatives formulated above.

Naphthalene-?-β-disulphonic Acid.—This acid is prepared by acting on naphthalene-β-monosulphonic acid with chlorosulphonic acid, and is certainly the chief product, but it remains to ascertain whether an isomer is not produced simultaneously. It is at once converted by the action of bromine into a dibromo-*mono*sulphonic acid; this behaviour renders it more than probable that the sulphonic radicle introduced by the agency of the SO_3HCl assumes an α- position.

The two acids prepared by Ebert and Merz by the action of sulphuric acid at a high temperature (160—180°) are in all probability β-β-derivatives; they are both isomeric with the acids obtained by sulphonating naphthalene-α- and β-*mono*sulphonic acids by means of SO_3HCl; and this difference being established between the action of sulphuric acid and that of chlorosulphonic acid, it appeared desirable to ascertain the behaviour with SO_3HCl of the naphthalene derivatives which had previously been converted into sulphonic acids in the ordinary manner. The derivatives taken were α-nitro-, α-bromo-, α-chloro-, and β-chloro-naphthalene: these have all been found to yield the same products when sulphonated by means of SO_3HCl as on treatment with sulphuric acid. It is especially noteworthy, however, that from both α-bromo- and α-chloro-naphthalene an acid has been obtained in small quantity isomeric with the *para*-sulphonic acid previously known, which forms the chief product; this secondary product is probably also an α-α-derivative like the primary product, but of the same series as the nitro-sulphonic acid formulated above. Two isomeric sulphonic acids also are obtained from β-chloronaphthalene. One, which is the chief product when SO_3HCl is used, has been shown by Arnell to correspond to θ-dichloronaphthalene, while the other corresponds to ε-dichloronaphthalene, and therefore to the β-disulphonic acid of Ebert and Merz, and to Schaefer's betanaphtholsulphonic acid. Probably θ-dichloronaphthalene is the ortho- or 1·2 modification, and it may almost be regarded as established that ε-dichloronaphthalene is a β^1-$\beta^{2'}$ derivative; so that, while α- and β-chloronaphthalene both behave in the manner to be expected from the analogy subsisting between benzene and naphthalene, evidence is afforded by the production of the α^1-$\alpha^{4'}$-derivative from the one and of the β^2-$\beta^{2'}$-derivative from the other of the existence in the naphthalene molecule, in addition to the "para-plane" of benzene, of two "planes of symmetry," as it were, in which an influence is exercised.

The study of the action of bromine on aqueous solutions of the naphthalene-sulphonic acids has also furnished results of interest. It has long been known that when napthalene-α-sulphonic acid is treated with bromine the sulphonic group is displaced, dibromonaphthalenes being formed, whereas the β-sulphonic acid is converted into a dibromonaphthalene-sulphonic acid, the SO_3H group retaining its place. It now appears that this behaviour of the two acids is fairly typical. Thus the two disulphonic acids of Ebert and Merz—which are doubtless both β β-derivatives—yield isomeric dibromonophthaquinone-*mono*sulphonates on treatment with bromine in excess—only one of the sulphonic radicles, viz., that which is contained in the C_6 group which is oxidised, being displaced. The isomeric dibromomonosulphonic acids obtained by treating (*a*) naphthalene β-monosulphonic acid and (*b*) the ?-β-disulphonic acid above described with bromine are finally converted by the action of bromine into the same tetrabromonaphthaquinone, the sulphonic

radicle being displaced, although in the β-position, in consequence of the oxidation to quinone of the C_6 group in which it is located. The γ-disulphonic acid—which is doubtless an α-α-derivative—readily parts with both its sulphonic radicles, yielding as final products dibromonaphthaquinone and what appears to be a hexabromonaphthalene. A further illustration of the stability of a β-sulphonic radicle is afforded by the behaviour of (Schaefer's) betanaphtholsulphonic acid with bromine, the end product being a bromohydroxyquinone *sulphonate*.

The results thus briefly recorded have been obtained with the assistance of Messrs. F. W. Streatfeild, S. Williamson, and W. P. Wynne, B.Sc.

It is anticipated that by the time of the next meeting of the Association the investigation of isomeric naphthalene derivatives will have been carried sufficiently far to render possible a fairly complete statement of the laws of substitution in the naphthalene series in the shape of a final report.

ANALYSES OF COMMERCIAL FERTILISERS.*

(Continued from p. 319.)

THE report of the Committee on Potash was next submitted by the Chairman, Dr. Gascoyne:—

Report of the Potash Committee.

As required by the constitution of the Association the Committee on Potash herewith presents a brief report on work done during the past year. Last January your Committee sent six samples containing potash to fifteen official and commercial chemists, accompanied by the following circular letter:—

"Richmond, Va., January 6, 1886.

"Dear Sir,—In behalf of the Committee on Potash appointed by the Association of Official Agricultural Chemists at the Washington Meeting last September, I send you by express six samples containing potash, numbered 1 to 6, respectively.

"Please determine in them potash by the method adopted by the Association at the Washington meeting and also any other method you may desire to try. When the work is done please report results to me with detailed accounts of methods employed other than that adopted by the Association.—Very truly yours,

"W. J. GASCOYNE,
"Chairman Potash Committee."

In the preparation of these samples chemically pure potassium salts were used, the materials very carefully mixed, and the samples sent to the members in sealed bottles.

The following is a description of the samples:—

No. 1. Potassium sulphate C.P.

No. 2. Commercial kainite.

No. 3. Acid phosphate, with pure potassium sulphate, sodium chloride, and magnesium sulphate, containing 2·70 per cent of potash.

No. 4. Acid phosphate, with pure potassium sulphate, potassium chloride, and potassium nitrate, containing 4·09 per cent of potash.

No. 5. Acid phosphate, with potassium sulphate, sodium chloride, and cotton-seed meal, containing 3·19 per cent of potash.

No. 6. Acid phosphate, with potassium sulphate, potassium chloride, and sodium nitrate, containing 2·25 per cent of potash.

The results are given in two tables, the first of which gives the results by the Association method, and the other by the method suggested by Mr. T. S. Gladding at the last meeting of the Association.

* From the *Proceedings* of the Third Annual Convention of the Association of Official Agricultural Chemists, at Washington, D.C. August 26 and 27, 1886. Edited by Clifford Richardson, Secretary.

POTASH DETERMINATIONS.

Association Method.

Analyst.	K_2O No. 1.	K_2O No. 2.	K_2O No. 3.	K_2O No. 4.	K_2O No. 5.	K_2O No. 6.
A ..	53·99	12·86	2·75	3·95	3·26	2·19
B ..	54·09	13·11	2·56	3·80	2·61	1·20
C ..	54·02	13·05	2·68	3·92	3·20	2·21
D ..	53·76	13·33	2·71	3·79	3·18	2·17
E ..	53·88	13·42	2·71	3·75	3·07	2·19
F ..	53·98	13·04	2·57	3·91	3·20	2·20
G ..	54·00	13·32	2·76	3·87	3·50	2·34
H ..	54·08	13·65	2·58	3·89	3·22	2·13
I ..	53·12	13·43	3·10	4·05	3·59	2·62
J ..	53·88	—	—	—	—	—
K ..	53·33	15·46	2·57	3·76	2·71	2·05
L ..	53·96	12·06	2·42	3·40	1·95	1·86
Average	53·88	13·33	2·67	3·83	3·03	2·10

Lindo-Gladding Method.

C^1 ..	53·96	12·95	2·74	3·86	3·13	2·19
L^1 ..	53·49	12·67	2·41	3·63	2·89	1·94
M ..	54·00	13·05	2·54	3·79	3·13	2·26
Average	53·82	12·89	2·56	3·76	3·05	2·13

In the table below are given the average results by the Association method, with the highest and lowest determinations:—

	Average.	Highest.	Lowest.	Difference.
No. 1	53·88	54·09	53·12	0·97
No. 2	13·33	15·46	12·06	3·40
No. 3	2·67	3·10	2·42	0·68
No. 4	3·83	4·05	3·40	0·65
No. 5	3·03	3·59	1·05	1·54
No. 6	2·10	2·62	1·20	1·42

In results by the Lindo-Gladding method, in sample No. 1, the difference between the highest and lowest determination is 0·51 per cent.

In No. 2 the difference between the highest and lowest determination is 0·38 per cent.

In No. 3 the difference is 0·33 per cent.

In No. 4 the difference is 0·23 per cent.

In No. 5 the difference is 0·24 per cent.

In No. 6 the difference is 0·32 per cent.

The report of the committee having been accepted, it was moved that the place of N. W. Lord, who was not present, be filled by the President.

He named Professor M. A. SCOVELL, of Kentucky.

Discussion being in order, Professors MCMURTRIE and CHAZAL stated their objections to the use of a porcelain dish for driving off ammonia salts and organic matter.

Professor SCOVELL said—Mr. President, I wish to call attention in the official method of estimating potash to the use of a porcelain dish in which the potash solution is brought to dryness and the ammonic salts volatilise. In my own case I find it almost impossible to volatilise all the ammonia salts in a porcelain dish below a red heat, especially if not re-dissolved and re-ignited; this portion of the method is apt to mislead, and I would suggest the use of a platinum dish instead of porcelain. Unless great care is taken the results will be too high by the use of a porcelain dish.

Professors WHITE and MOSES called attention to the difficulty of washing the barium precipitate and the necessity of using boiling water repeatedly.

Dr. JENKINS said—A source of error in potash determination is this. In presence of a considerable quantity of alkali chlorides it is impossible perfectly to separate magnesia by barium hydrate, and if insufficient platinum chloride is used, the results obtained may be too high. The error may be avoided by adding in every case a very considerable excess of platinum solution.

Another and more common source of error is imper-

fect washing of the precipitate produced by $BaCl_2$ and $Ba(OH)_2$. It is well known that $BaSO_4$ is apt to carry down with it soluble salts, and the gelatinous precipitate of barium phosphate is also hard to wash. I always use from 350 to 500 cubic centimetres of wash water, washing several times by decantation with boiling water before before bringing the precipitate on a filter.

Professor CHAZAL objected to the fact that the use of the Gooch crucible should be required, and desired that the method of filtration should be optional.

Professor MOSES considered washing the double salt through the filter with hot water and afterwards evaporation and weighing as being as convenient as the Gooch crucible.

Dr. GASCOYNE called the attention of the members to the atomic weight of platinum by W. Halberstadt, in *Zeit. für anal. Chem.*, Heft 2, 1886.

Halberstadt gives as the mean of about 100 determinations 194·5759 as the atomic weight of Pt, thereby confirming the atomic weight as given by Seubert.

He also spoke upon the Lindo method as modified by Gladding, and recommended its examination by chemists, being confirmed by Mr. Richardson, who thought the use of the half-saturated solution of NH_4Cl, according to Gladding's method, would be found advantageous in any case. Dr. White suggested that the Gladding method be reported as an alternative, and also brought up the question of precipitating with barium chloride, hydrate, and ammonic carbonate in an original portion of two grms. of the fertiliser without intermediate filtration.

Dr. WILEY said that on page 32 of the *Proceedings* for 1885 this had been abandoned.

Dr. RICHARDSON asked for opinions in regard to use of oxalic acid.

Mr. JENKINS saw no necessity, and gets higher results in kainite without it.

Professor MYERS said that he had made some comparative analyses, possibly thirty or forty determinations with the use of oxalic acid and without, using simply carbonate of ammonium.

Without having the figures with him he would state that the results appear to be equally accurate, except in the case of kainite, in which there is trouble unless oxalic acid is used, and even this fails, without care, to remove the impurities.

Dr. GASCOYNE found it useful in removing something not precipitated by ammonic carbonate.

Professor SCOVELL thought the evaporation after addition of platinum should be carried further than a syrup, to remove all HCl, as he considered the double salt somewhat soluble in this.

Dr. JENKINS said he found there was no appreciable effect from this cause, but that going to dryness would produce no injury. The concentration of the alcohol used for washing was not vital.

On a question from Mr. Richardson, no objection was raised to the use of the old factors for the conversion of K_2PtCl_6 to K_2O.

(To be continued.)

NOTES ON THE ANALYSIS OF CHROME PAINTS.

By WALTER LEE BROWN.

HAVING had considerable experience, and not a little trouble, in the analysis of the above paints, I have thought the following notes might be of some aid to the student undertaking such work.

At first glance, and from merely reading over the directions given in the text-books, these analyses seem very simple and easy; they may be the former, but certainly not the latter. Much care and attention to detail are necessary.

The dry chrome paints come on the market in several forms, as lemon-chrome or chrome-yellow, orange-chrome, basic chromate of lead, and chrome-green. They can also be procured ground.

I. *Analysis of Mixed Chromate and Sulphate of Lead* (lemon-chrome or chrome-yellow).—Pulverise the sample, pass through a 100-mesh sieve, and mix. To 1 grm. in a small beaker add HCl and heat. Any insoluble matter (usually barytes as a gross adulteration) is to be filtered out, washed, ignited, and weighed. Further, its weight is to be deducted from that of the total lead weighed as sulphate.

Lead.—1 grm. is treated in a covered casserole with 25 c.c. concentrated H_2SO_4, and heated moderately until the residue is perfectly white; cool, dilute with 50 c.c. water, and again cool; add 50 to 75 c.c. of 94 per cent alcohol, stir, and allow to stand one hour. Filter, wash with alcohol as usual, dry, heat, precipitate, and incinerate ash (after treatment with HNO_3 and H_2SO_4) half hour, heat again fifteen minutes, cool, and weigh. The successive weighings should not vary more than 2-10ths m.grm.

The process ordinarily performed with HCl and alcohol does not, in our hands, give good results.

The $PbCl_2$ formed will stay neither entirely on the filter nor in the filtrate, and causes trouble all the way through. After repeated trials we had to give it up.

Chromium and Sulphuric Acid (SO_3).—Treat 1 grm. with about 25 c.c. concentrated HCl, boil, dilute to 100 c.c., and while hot add excess of NH_4HO, which precipitates the chromium and the greater part of the lead. Boil off the excess of ammonia, filter, and wash *very carefully* with hot water.

Precipitate.—PbS reject.

Filtrate.—Boil off every trace of H_2S and precipitate Cr with NH_4HO in the usual manner. Put the moist precipitate and filter-paper into a crucible and ignite carefully. Weigh as Cr_2O_3.

Precipitate for Cr.—Dissolve in dilute HCl, neutralise excess of acid with NH_4HO, precipitate Pb with H_2S gas, and filter into a *porcelain dish*.

Filtrate for SO_3.—Acidify with HCl, concentrate, add boiling $BaCl_2$ drop by drop, and determine SO_3 as usual, taking care to wash very thoroughly with hot water.

Occasionally the following determinations are made :—

Water—hygroscopic. Heat ½ grm. at 220° F. in air-bath to constant weight.

Volatile Matter.—Heat 1 grm. in porcelain crucible to gentle redness; loss, less water, is volatile matter.

Water Extract.—(Acetates, sulphates, bichromates, or nitrates of soluble salts, indicating imperfect washing.) Treat 3 grms. with six successive portions of 25 c.c. each of cold distilled water, decanting and filtering each time, and evaporate the filtrate in a platinum dish to dryness on a water-bath.

Calculations.—There are quite a few of these, and the use of factors, as shown by the following example, will save some little time.

Example.—21·62 per cent $BaSO_4$ obtained; 21·62 × 1·3 = 28·10 = per cent $PbSO_4$. 21·62 × 0·888 = 19·19 = per cent Pb in the 28·10 per cent $PbSO_4$ calculated from the 21·62 per cent $BaSO_4$.

Cr_2O_3 obtained = 16·87 per cent; 16·87 × 4·241 = 71·54 = per cent $PbCrO_4$.

16·87 × 2·716 = 45·81 = per cent Pb in the 71·54 per cent $PbCrO_4$ calculated from the 16·87 per cent Cr_2O_3.

Total Pb (weighed as $PbSO_4$)	64·45	per cent.
Pb belonging to the $PbSO_4$	19·19	,,
Pb remaining for $PbCrO_4$	45·26	,,
Pb calculated from the Cr_2O_3	45·81	,,
Difference	0·55	,,

The 45·26 per cent Pb calculated to $PbCrO_4$ (45·26 × 1·561) = 70·65, which is considerably different from the 71·54 obtained from the Cr_2O_3 end. Theoretically, the

such cases, and when delicacy of determination is not needed, or time is not available, the fairest way is to average, as one cannot always tell where to place the error. Thus the average of 71·54 and 70·65 = 71·09, this plus 28·10 per cent $PbSO_4$ gives a total of 99·19.

2. *Analysis of Mixed Chromate, Sulphate, and Carbonate of Lead* (lemon-chrome and white-lead).—Analysis made same as for 1; excess of lead is to be calculated as white-lead, $2PbCO_3+PbH_2O_2$.

Example.—A sample contained 11·47 per cent $PbSO_4$ and 48·78 per cent $PbCrO_4$ (the latter calculated from the Cr_2O_3). Pb in the $PbSO_4$, 7·83 per cent, Pb in the $PbCrO_4$, 31·22; the sum of these, 39·05, deducted from the total lead, 69·95, leaves 30·90; $30·90 \times 1·248 = 38·56$ = per cent white-lead.

Resumé:		
$PbSO_4$	11·47	per cent.
$PbCrO_4$	48·78	,,
$2PbCO_3+PbH_2O_2$ ..	38·56	,,
	98·81	,,

Water, volatile matter, and water extract not determined.

3. *Analysis of Orange Chromate of Lead* (chrome-orange).—Process same as for 1. Very litttle $PbSO_4$ will usually be found. Closer results will generally be obtained from this paint than from the mixed chromes.

Example.—A sample recently examined gave $PbCrO_4$ from the Cr end, 99·41 per cent; from the Pb end, 99·34 per cent; difference, 0·07 per cent. Total analysis as follows:—

$PbCrO_4$	99·37	per cent (average).
$PbSO_4$	0·16	,,
Volatile matter	0·50	,,
	100·03	

4. *Analysis of Mixed Orange Chromate, Sulphate, and Carbonate of Lead.*—Same as for 2. Example:—

$PbSO_4$	2·73	per cent.
$PbCrO_4$	71·40	,,
$2PbCO_3+PbH_2O_2$	24·56	,,
	98·69	

5. *Analysis of Red Chromate of Lead* (known by many names, as scarlet, dark or basic chromate of lead, chrome red, Chinese red, red paste, American vermilion, and vermilion substitute).—Formula, $Cr_2Pb_3O_9$ or—

$$2PbCrO_4+PbO.$$

For the Pb determination take 1 grm. in covered casserole, add 25 c.c. concentrated HNO_3, heat to boiling, and *while boiling* add half a dozen drops, one at a time, of alcohol, by means of a pipette; boil a while longer, add water, and all of the chromate, if it is pure, will be found to be in solution. Without this alcohol treatment great difficulty will be experienced in getting the chromate into solution; with it, it becomes very easy. Add 25 c.c. concentrated H_2SO_4, evaporate to white fumes, and complete the analysis as described. For Cr and SO_3 determinations boil off alcohol and proceed as previously directed.

Calculations.—Calculate the SO_3 (if there should be any) to $PbSO_4$, and the Cr_2O_3 to $2PbCrO_4$, and subtract their Pb from the total Pb, and figure the remaining Pb to PbO.

Example.—Cr_2O_3 obtained, 13·32 per cent = 56·49 per cent $2PbCrO_4$ and 36·17 per cent Pb. Total Pb = 74·04 per cent; deduct 36·17 and 1·77 (from the SO_3 found), leaving 36·10 for PbO. $36·10 \times 1·077 = 38·87$ per cent PbO.

Resumé:		
$2PbCrO_4+PbO$	95·36	per cent.
$PbSO_4$	2·60	,,
Volatile matter and water	1·24	,,
	99·20	

also sulphate of lead.

To 1 grm. of the sample add 25 c.c. HCl, heat to boiling several minutes, add water, allow to stand a while, then filter and wash thoroughly with hot water.

Residue.—Prussian blue (plus barytes or other insoluble matter, if present). Dry and ignite to Fe_2O_3. Weight multiplied by 2·212 equals per cent Prussian blue. See Cr. det.

Filtrate.—Nearly neutralise with NH_4HO, leaving, however, the solution slightly acid. Pass H_2S gas through till Pb is all precipitated. Filter and wash.

Precipitate.—PbS. Dissolve on filter with hot dilute HNO_3 (1·4), and boil solution. Filter from collected S, and bring filtrate of $Pb(NO_3)_2$ to small bulk with several additions of H_2SO_4. Evaporate to fumes of H_2SO_4, cool, add water and alcohol, filter, wash and weigh as $PbSO_4$ as usual.

Filtrate.—For Cr (and Fe) boil off H_2S, add NH_4HO in slight excess, boil this off, and wash the $Cr_2(OH)_6$ (and $Fe_2(OH)_6$) as customary. Weigh precipitate as $Cr_2O_3+Fe_2O_3$. After the weight is obtained mix with 1 part KNO_3 and 3 parts Na_2CO_3, fuse in platinum crucible to clear fusion, cool, boil with water, filter, and wash.

Filtrate.—For Cr. Precipitate with NH_4HO in glazed porcelain dish as usual. If the weight of Cr_2O_3 is *very nearly* the same as before, then there has been no Fe extracted from the Prussian blue by the acid treatment. Some varieties are affected by this, others are not. If the weight is less than the original, deduct it from same; the result is Fe_2O_3, which is also to be calculated to Prussian blue and added to the other.

Residue.—Filter, wash, dry, ignite, and weigh as Fe_2O_3, if it is wanted as a check.

Sulphuric Acid.—One grm. heated with 25 c.c. HCl, filtered from Prussian blue, and SO_3 in the filtrate determined as directed under 1.

Calculations.—If there is more Pb than is sufficient to combine with all the Cr and SO_3, and a qualitative test shows presence of CO_2, then calculate excess of Pb to $2PbCO_3+PbH_2O_2$.

Example.—Prussian blue. Per cent of Fe_2O_3 obtained from the two separations as described, 1·755, multiplied by $2·212 = 3·88$ per cent Prussian blue; per cent of Cr_2O_3, $9·20 = 39·01$ per cent $PbCrO_4$; per cent of SO_3, $10·56 = 40$ per cent $PbSO_4$; Pb in $PbCrO_4$ and $PbSO_4$, 52·28 per cent: total Pb 65·54, deduct 52·28, remainder 13·26 per cent = 16·54 per cent $2PbCO_3+PbH_2O_2$.

Prussian blue	3·88	per cent.
$PbCrO_4$..	39·01	,,
$PbSO_4$	40·00	,,
$2PbCO_3+PbH_2O_2$	16·54	,,
Total	99·43	

Table of Factors.

(Ba=137, C=12, Cr=52·2, Fe=56, H=1, K=39, N=14, O=16, Pb=207, S=32.)

Found.	Sought.	Multiply by factor.
a	*b*	$\frac{b}{a}=f$
$BaSO_4$ (233)	$PbSO_4$ (303)	1·300
$BaSO_4$ (233)	Pb (207)	0·888
Cr_2O_3 (152·4)	$2(PbClO_4)$ (646·4)	4·241
Cr_2O_3 (152·4)	2Pb (414)	2·716
Fe_2O_3 (160)	$K_2Fe_2(FeCN)_2$ (354)	2·212
Pb (207)	PbO (223)	1·077
Pb (207)	$PbCrO_4$ (323·2)	1·561
3Pb (621)	$2PbCO_3+PbH_2O_2$ (775)	1·248
$PbCrO_4$ (323·2)	Pb (207)	0·640
$PbSO_4$ (303)	Pb (207)	0·683
SO_3 (80)	$PbSO_4$ (303)	3·7875

With all these chrome paints a qualitative analysis should always precede, in order to make such modifications of the after treatment as may be necessary.

To determine the mixing fluid in any ground chromate, tare a small beaker and weigh into it from 10 to 15 grms. of the paint. Stir the paint three times with naphtha, using about 25 c.c. each time, and withdrawing the mixing fluid solution by means of a small suction pipette, such as is used for filling stylographic pens, &c. Finally, treat once with ether, withdraw same, dry beaker and contents, and weigh; loss equals mixing fluid.

References. — Fresenius's "Quantitative Analysis"; Rammelsberg's "Guide to a Course of Quantitative Chemical Analysis"; Wöhler's "Handbook of Mineral Analysis"; Normandy's "Commercial Handbook of Chemical Analysis"; "Simple Exercises in Technical Analysis" (entirely on Paints), in "English Mechanic and World of Science," London, from August 8th, 1884, to date, at intervals; "Painting and Painters' Materials," by C. L. Condit.

Credit is herewith given to my assistants, George H. Ellis and E. Speidel, and to E. M. Bruce, for the careful working out of the processes described in this article.—*School of Mines Quarterly*, October, 1886.

NOTICES OF BOOKS.

Select Methods in Chemical Analysis (chiefly Inorganic). By William Crookes, F.R.S., V.P.C.S., Editor of the Chemical News. Second Edition, re-written and greatly enlarged. London: Longmans, Green, and Co.

A work written by the Editor of the Chemical News cannot, of course, be noticed in its pages in the same manner as one from any other source. Instead of discussing the merits or demerits of the work before us we must confine ourselves to point out its relations to the earlier edition, and to the whole scope of modern knowledge in analytical chemistry. In the first place the reader will soon perceive that the author has not attempted "to produce an encyclopædia of chemical analysis, in which is laid down every good method for the qualitative and quantitative examination of every known substance under every possible combination of circumstances." He has intentionally omitted: firstly, all methods and operations which are practised in every laboratory, and which are known to every student who has at all passed beyond the elementary stages; secondly, all procedures—possibly excellent—which he has not had the opportunity of personally verifying; and lastly, all such methods as are of questionable value. Such processes as many of our readers know possibly too well are neither few nor far between.

It will further appear that the analysis of organic compounds, qualitative or quantitative, industrial or purely scientific, has been left untouched. The vexed question of water analysis has also been omitted. Formulæ of any kind have been used only where required for the sake of identification, the author doubtless thinking, with Fresenius, that a treatise on chemical analysis is not the place for their ventilation. The various processes inserted have been, as far as possible, reproduced from the original memoirs, retaining the systems of weights and measures selected by their respective authors. The Centigrade thermometric scale has, however, been used, except where it is expressly stated to the contrary.

Among the essential features of the work, which have been not only retained but extended, must rank a number of little-known expedients and precautions—"shifts and dodges," as some chemists call them—which prevent mistakes, insure accuracy, and economise time. Such expedients are traditional in many of the leading laboratories, but they rarely find their way into abridged manuals and text-books, and hence they do not always come to the knowledge of every student.

The new or improved features introduced in this edition include methods for gas analysis—a branch which has been greatly developed since the appearance of the first edition; the detection and isolation of the metals of the rare earths, a subject which has occupied much of the author's time during the last eight years, and with which he is still engaged; the separation of gallium from accompanying bodies; the novel indicators introduced in alkalimetry and acidimetry; the most recent improvements in the analysis of the metals of the platinum group and of phosphoric acid in commercial phosphates. There will be found further a great number of novel or improved methods for the recognition or determination of various bodies, which to catalogue would be alike tedious and uninteresting.

As far as can be traced out, little falling within the plan of this work, and appearing prior to date of its publication, has escaped notice.

The Glucosides. By Dr. O. Jacobsen. Breslau: Trewendt.

This treatise is a reprint from the *Handwörterbuch der Chemie*, edited by Prof. A. Ladenburg, which again appears to be included in the Encyclopædia of the Natural Sciences (Encyklopædie der Naturwissenschaften) now being issued by the publisher above named.

The author defines the glucosides as compounds occurring almost exclusively in the vegetable kingdom, which, under various circumstances, take up water, and are split up into a sugar, and some other body not belonging to the sugars.

The sugars thus formed are either ordinary glucoses or special glucoses (some of which appear incapable of fermentation, and some optically inactive). Other glucosides do not yield a glucose at all, but bodies such as chinorite and isodulcite, which approximate more or less closely to the glucoses.

The glucosides are considered, generally speaking, as etheroid derivatives of the sugars in question. The bodies present along with such sugars or saccharoid bodies belong to very different groups, either of the aromatic or the fatty series. Thus we find hydrocarbons, alcohols, aldehyds, acids, diketones, nitriles, mustard oils, phenoles, and bases. In very many cases, however, the chemical nature of the bodies thus split off has yet to be determined. The decomposition is effected either by heating with a dilute acid—sulphuric, hydrochloric, or oxalic—with an alkali, or in some cases very slowly by boiling or superheating with pure water. The choice of the acid employed is not always a matter of indifference.

Ferments also, especially emulsine, have the power of splitting up glucosides, either at the ordinary temperature or with the aid of heat.

Some glucosides seem to contain in their molecule several sugar-residues which may be successively split off by treatment with dilute acids.

The signification of glucosides for the vegetable organism has not yet been determined. But it seems probable that glucosuccinic acid or, perhaps, several closely allied glucosides, must rank among the first products of assimilation.

After the introduction, of which we have thus given a brief sketch, the author proceeds to an enumeration of the glucosides in alphabetical order. He excludes, however, the tannins, which certainly yield sugars on boiling with dilute acids, but possess, in several respects, a distinct character.

Many of the glucosides, such as indican, quercetin, ruberythric acid, rutine, carminic acid, &c., possess a peculiar interest for the student of tinctorial chemistry, whilst others are of pharmaceutical importance.

As an appendix the author gives a very copious bibliography, giving references to no fewer than 649 memoirs,

The Eleventh Annual Report of the Chemical Examiner's Department of the Government of Bengal. By C. J. H. WARDEN, M.D.

THE report deals with the work done in the year 1885, in which year 2343 analyses were performed, being about 400 less than the number done in the previous year; of these analyses 234 were of human viscera, the examination being for poison, 780 were for poisons in various substances, and 205 were for blood stains. Thus we find more than half the work done was in the detection of actual or suspected crime; more than 600 analyses were simply for finding the quality and purity of the articles, which were principally Government stores and ammunition. The results of all these analyses are very carefully tabulated and clearly expressed, and should be of great interest not only to chemists but to medical officers of health.

The appendix deals very thoroughly with the character and properties of the plant known as Madar (*Calotropis procera*), which has very valuable medicinal effects. In syphylitic complaints it has been employed with such success as to be called "vegetable mercury." It is also exceedingly useful in reducing swellings, sprains, &c., and healing burns. The sap is very similar to guttapercha, and has even some advantages over this latter substance, while the fibre itself makes an admirable substitute for hemp.

Whitaker's Almanack for 1887. By J. WHITAKER, F.S.A. London.

THIS useful book of reference is gradually assuming larger and larger proportions, each successive year seeing some addition and improvement. One of the distinguishing features of the latest edition of this almanack, which happily comes in Her Majesty's jubilee year, is the greater importance given to the colonial section. The scientific summary gives the latest news in the various branches of science. In speaking of M. Pasteur's experiments on the prevention of hydrophobia we note that out of the large number of patients treated less than one per cent. have died, assuredly a most satisfactory result.

In a paragraph on nitroglycerin and dynamite we read that the power exerted by an explosion on surrounding objects is in the inverse ratio of the cube of the distance from the point of explosion; that is to say, if the force of an explosion were represented by 1,000,000 on the spot, the force at 100 feet distance would only equal 1. The most recent discoveries of chemical elements are also given; 42 have been discovered from 1877 to the present time, of which 8 were found in 1886.

The whole almanack abounds with interesting and useful information.

CORRESPONDENCE.

AN EXAMINATION PUZZLE.

To the Editor of the Chemical News.

SIR,—The fact that A. X. is an experienced analyst renders his position all the more inexplicable. Surely, in an examination on the principles of analysis, the candidate is supposed to be acquainted with analytical methods! I never yet heard of an analyst who tested his ammoniacal filtrate with $PtCl_4$ without previous evaporation and ignition. There is nothing in the question referred to produced by AmHo. On the contrary, does it not mention the group tests HCl, H_2S, AmHo, Am_2S_2, Am_2CO_3, followed by Na_2HPO_4 and $PtCl_4$ for Group V., plainly indicating that the usual course of qualitative analysis is to be followed?

Notwithstanding this, I maintain that if $PtCl_4$ *were* added directly to the ammoniacal filtrate it would give no precipitate, since the Am would be in a diluted condition.

As an experienced chemist, A. X. must know that there is more than one sodium silicate, and that the tetrasilicate ($Na_2S_4O_9$), when powdered, is readily soluble in boiling water.—I am, &c.,

A. P. S.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l' Académie des Sciences. Vol. ciii., No. 24, December 13, 1886.

Glucose, Glucogene, Glucogeny, in Relation to the Production of Heat and of Mechanical Work in the Animal Economy. Sketch of an Absolute Determination of the Proportion in which the Combustion of Glucose contributes to these Phenomena. Part played by the Liver.—A. Chauveau.—The liver constantly supplies glucose to the blood. This glucose, incessantly yielded to the organs in the capillaries of the general circulation, constitutes the principal support of the organic combustions; the sources of animal heat and of muscular work for this support takes from the blood the greater part of the oxygen absorbed in the capillaries. Moreover, all the conditions which modify combustions modify, in the same direction, the quantity of glucose consumed by the organs. The production of heat and of mechanical work are so well connected in the animal economy with the glucogenic function and the combustion of glucose, that the liver pours this substance more abundantly into the blood when one or more sets of organs are in active work. Inversely, when at the extreme limit of prolonged abstinence, the liver no longer receives from the exhausted economy the materials necessary for the exercise of the glucogenic function, sugar disappears entirely from the mass of the blood, and we have cessation of combustion, a reduction of temperature, and death.

An Epidemic of Typhoid Fever at Pierrefonds in August and September, 1886.—P. Brouardel.—The well of the house which was most severely attacked is by far the least charged with organic matter (8 to 9 m.grms. per litre).

Thermic Phenomena accompanying the Precipitation of Bimetallic Phosphates and Allied Salts.—A. Joly.—The author here extends his researches to bicalcic phosphate, bibaric phosphates and arseniates, strontia diphosphate, and monobaric hypophosphate.

Neutralisation-Heat of Glyceric and Camphoric Acids.—H. Gal and E. Werner.—This short memoir does not admit of useful abstraction.

Certain Coloured Reactions of the Arsenic, Vanadic, Molybdic, and Arsenious Acids, also of Antimony and Bismuth Oxides.—L. Lévy.—After having indicated certain distinctive reactions for the titanic, niobic, tantalic, and stannic acids, the author proceeds to describe the behaviour of other analogous acids under the same circumstances. Phosphoric acid gives no colouration. It is not the same with the arsenic, vanadic, and molybdic acids.

Reagents.	Arsenic Acid.	Vanadic Acid (before water).	Vanadic Acid (after water).
Morphine	—	—	Rose, then green.
Codeine..	—	Slightly green.	Violet precipitate, soluble in excess of water.
Phenol	—	Sepia.	Sepia.
Thymol	Sepia.	Yellowish.	Rose.
Naphthol α	Green.	Green.	Light green.
Naphthol β	Brown.	Green.	Light green.
Resorcine	Sepia.	Black-green.	Violet.
Hydroquinone ..	Yellowish.	Yellow-green.	Green.
Pyrocatechine ..	Greenish grey, then amethyst.	Black green.	Green.
Pyrogallol	Brown.	Sepia.	Rose.
Salicylic acid.. ..	—	—	Green.
Metaoxybenzoic acid	—	—	Rose.
Gallic acid	—	—	Greenish.

All the colourations due to arsenic acid are destroyed by water, save that produced by pyrocatechine; in this case we have a green liquid which is decolourised in course of time, giving a green precipitate. Molybdic acid colours only some of the above reagents: morphine becomes rose; resorcine sepia; codeine and the naphthols turn green; but all the reagents, if tested with the other acids, give, in presence of water, green precipitates. From the above table it is seen that we may clearly distinguish:—(1) Arsenic acid mixed with phosphoric and vanadic acid by the aid of pyrocatechine; (2) The latter substance mixed with its isomers by the aid of arsenic acid; (3) Vanadic acid mixed with molybdic and phosphoric acid by means of resorcine. Phosphorous, tungstic, and boric acids have no action, but bismuth and antimony oxides, as well as arsenious acid, yield coloured reactions.

Reagents.	Bismuth Oxide (before water).	Bismuth Oxide (after water).	Antimony Oxide and Arsenious Acid.
Morphine	Slight rose.	—	—
Codeine	,,	—	Very pale lilac with arsenious acid alone.
Phenol	—	Rose.	Very slight rose.
Thymol	—	Rose.	Flesh.
Naphthol α	—	—	Green.
Naphthol β	—	—	Yellow.
Resorcine	—	Orange.	Sepia.
Hydroquinone ..	—	—	—
Pyrocatechine ..	Greenish.	Deep green.	Flesh.
Salicylic acid ..	Green, almost black.	—	Flesh.
Isomers of the preceding..	—	—	—

The colours due to arsenious acid and antimony oxide disapper on the addition of water. The bismuth oxide must be quite free from nitro-compounds, which would furnish colours more intense. This table shows that by the aid of pyrogallol bismuth oxide may be recoguised in presence of arsenious acid and antimony oxide. The same table, along with the foregoing, shows that arseniates may be distinguished from arsenites by pyrocatechine, whilst α-naphthol and water characterise tin in presence of arsenic, antimony, and bismuth.

Biedermann's Central Blatt für Agrikultar Chemie.
Vol. xv., Part 7.

Purification of Industrial Waste Waters.—Prof. Alex. Müller and Dr. Bodenbender.—The authors distinguish two methods of treatment: the cellular-chemical, which aims at removing organic impurities by setting up among them processes of fermentation and putrefaction; and the molecular-chemical, which is known in this country as precipitation. They point out that carbohydrates in sewage have an injurious effect upon vegetation and occasion acidity in the soil.

Determination of Organic Carbon in Soils which seize upon Free Nitrogen.—M. Berthelot.—From the *Comptes Rendus.*

Composition of the Sediment in the Settling-Tanks of Sugar Works.—Prof. Farsky.—The deposit contains 43·5 per cent of water, 0·0183 nitrogen, 0·9967 phosphoric acid, and 0·0356 potash.

Enrichment of Nitrogen in a Plot of Meadow Land.—P. P. Dehérain.—It appears that soils intensely cultivated become poorer in nitrogen, but grow richer again if the soil is planted with legumens and grass. This confirms the view that the want of plant-food in a soil cannot be determined by the constituents removed in the crops.

Determination of Ammonia in the Soil.—MM. Berthelot and André.—From the *Comptes Rendus.*

Action of Ferrous Oxide upon Vegetation.—Dr. O. Kellner.—The occurrence of readily soluble ferrous compounds is to be regarded as a symptom of insufficient aëration of the soil, but such salts are not to be considered as directly injurious.

A Phosphatic Earth from Bergstadt.—Prof. Farsky.—This soil contains 36·024 per cent calcium phosphate, 7·240 ferric phosphate, and 0·968 aluminium phosphate.

Manurial Experiments with different Phosphates on Barley and Oats.—H. Sellschopp.—The exclusive use of Chili saltpetre gives the highest nett value of grain in the case of barley. Superphosphate and precipitated phosphate proved nearly equal both for barley and oats. Finely ground Gilchrist and Thomas slag proved inactive or even injurious.

The Efficacy of Chili Saltpetre as compared with that of Ammoniacal Salts according to the Experiments of Lawes and Gilbert.—Professor Maercker.—The author holds that the alleged injurious action of ammoniacal salts is for the present not demonstrated, and does not occur in normal conditions of the soil. Ammoniacal salts are best adapted for carefully cultivated clay-soils rich in clay.

The Formation of Fats in the Body of Carnivora from Carbohydrates.—Dr. Max Rubner.—The facts lead to the conclusion that fat may be formed from the carbohydrates in the bodies of carnivora.

matter and of doubtful efficacy. Only 7 per cent of the carbohydrates can be regarded as easily digestible.

Moniteur Scientifique, Quesneville.
3rd Series. Vol. xvi., September, 1886.

German Review.—A memoir on para-amido-acetophenone, ortho-, amido-acetyl toluene, and certain derivatives of these bodies, by M. Klingel, taken from the *Berichte*.

Report on Alcoholism presented to the Academy of Medicine.—The consumption of distilled spirit increases yearly in France in an alarming manner, having doubled itself within forty years, and being to a great extent substituted for wine. The relatively mild drunkenness occasioned by wine has given place to the intoxication produced by distilled liquors containing a higher proportion of propylic, butylic, and amylic alcohols. "Fortified" wines are also rendered dangerous by the introduction of the higher alcohols.

The Naphtha of Baku.—Prof. Mendeleeff.—A consideration of these naphtha wells from a commercial point of view.

The Valuation of Manganese.—W. Atkinson.—From the *Journal of the Society of Chemical Industry*.

Volumetric Assay of Manganese.—J. Pattinson.—From the *Journal of the Chemical Society*.

On Maumené's Assay of Oils.—C. J. Ellis, F.C.S.—From the *Journ. Soc. Chem. Industry*.

Note on Maumené's Method for the Assay of Oils.—C. J. Ellis, F.C.S.—From the *Journ. Soc. Chem. Industry*.

On Saccharine.—With reference to the proposal to mix starch-sugar with saccharine, so as to bring up its sweetening power to the level of cane-sugar, Dr. Von Lippmann admits that the flavour of saccharine is often unpleasant, especially on prolonged use. Crude glucose (especially that made from potatoes) cannot be consumed as such on account of its bad taste. In Germany the sale of glucose mixed with saccharine, under the name of cane sugar, would be an infraction of the law.

The Progress of Chemistry and Mineralogy.—M. Friedel.—The Presidential Address delivered at the Meeting of the French Association for the Advancement of Science, held at Nancy, 1886.

Properties and Proprietors of Ungreenable Aniline-Black.—Camille Kœchlin.—A continuation of the Grawitz controversy.

Journal de Pharmacie et de Chimie.
Series 5, Vol. xiv., No. 7, October 1, 1886.

Report on the Project of Supplying Paris with Water from the Springs of La Vigne and Verneuil.—A. Riche.—Paris is at present supplied with two kinds of water: an inferior quality, fit for industrial purposes, washing courts, couch-houses, watering gardens, &c., taken from the Seine above Paris, the Marne, and the Ourcq; and a better kind, fit for alimentary purposes, from the springs of La Dhuys and La Varne. The former kind is furnished at the rate of 172 litres per head of the population, and the latter only at that of 59 litres. In certain districts the two kinds are allowed to mingle. There are quarters where the spring-water is not laid on at all, and these include the barracks, the military hospitals, and a great number of schools. The water of the Seine, even above Paris, is contaminated by the drainage of starch works, distilleries, depôts of night-soil, and manufactories of poudrette. The proposed supplies of water are drawn from the chalk. The analyses show of the springs. Their number is respectively 48 and 28·5 per c.c. Culture experiments have not been tried, the author considering this investigation unnecessary in the case of waters which have undergone a filtration so prolonged.

The Microbia of the Soil.—E. Laurent.—The author concludes that the action of the microbia is most useful in soils rich in organic detritus.

Preparation of Oxygen.—Into a gas apparatus are introduced 1 kilo. of oxygenated water at 3 per cent and 500 grms. of dilute sulphuric acid (1:5). Into this mixture is poured, by means of a funnel drawn out to a point and curved at its lower extremity, 56 grms. crystalline permanganate dissolved in 896 grms. of water. The yield is about 20 litres of oxygen.

Determination of Phenic Acid.—H. Beckurts.—The *Pharmacopœia Germanica* recommends a method due to Mr. Crookes, which consists in shaking up in a graduated tube a known volume of the phenic acid under examination with a dilute solution of caustic soda, and after settling to measure the volume of the hydrocarbon not dissolved. But as cresol and xylol behave in a manner very similar to phenol, Beckurts takes a measured volume of crude phenol, adds to it an equal volume of petroleum ether, and agitates in a graduated tube with a solution of 1-10th caustic soda. The petroleum ether renders the separation of the alkaline stratum more distinct, and it is easy to find by evaporation the quantities of neutral and resinous substances which it has dissolved. A part of the alkaline solution is introduced into a graduated cylinder supersaturated with hydrochloric acid, and the quantity of phenol set at liberty is determined. The separation of the phenol is complete only when the solution of sodium chloride is saturated, which renders it necessary to concentrate the alkaline solution of phenol down to the half its value. Phenol may retain 33 per cent of water and cresol only 15 per cent. Phenol retains about as much water as the solution of sodium chloride retains phenol.

Aluminium Oleate: its Use for Thickening Mineral Oils.—From the *Chemist and Druggist*.

Determination of Uric Acid.—Mr. Haycraft.—From the *Journal of the Chemical Society*.

Ulexine.—W. Gerrard.—From the *Pharmaceutical Journal*.

Phenyl-hydrazine.—M. Jaksch.—From the *Journal of the Chemical Society*.

The Vapour-Tensions of Bromine, Iodine, and Iodine Monochloride.—W. Ramsay and Sydney Young.—From the *Journal of the Chemical Society*.

MEETINGS FOR THE WEEK.

MONDAY, 3rd.—London Institution, 5.
—— Medical, 8.30.
—— Society of Chemical Industry, 8. "On the Explosive Kinetite," by Watson Smith; and other papers.
TUESDAY, 4th.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.
—— Pathological, 8.30. (Anniversary).
THURSDAY, 6th.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.
—— Royal, 4.30.
—— Royal Society Club, 63·0.
—— London Institution, 6.
FRIDAY, 7th.—Geologists' Association 8.
SATURDAY, 8th.—Royal Institution, 3. "The Chemistry of Light and Photography," by Professor Dewar, M.A., F.R.S.

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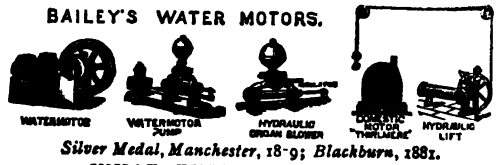

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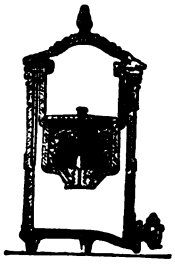

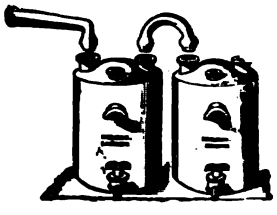

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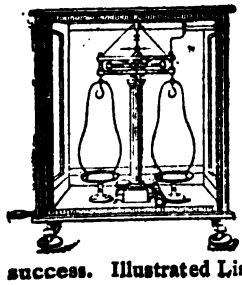

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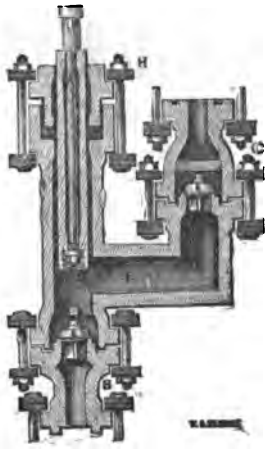

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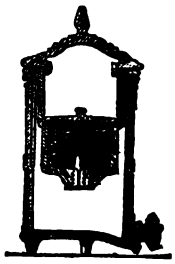

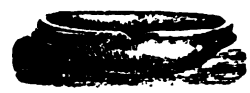

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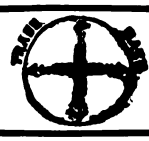
Quality Guaranteed by Name and  *Trade-mark on Original Packages.*

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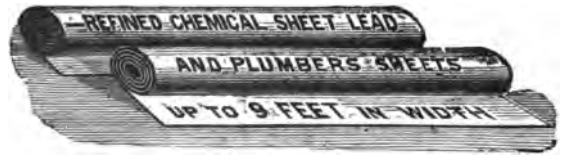

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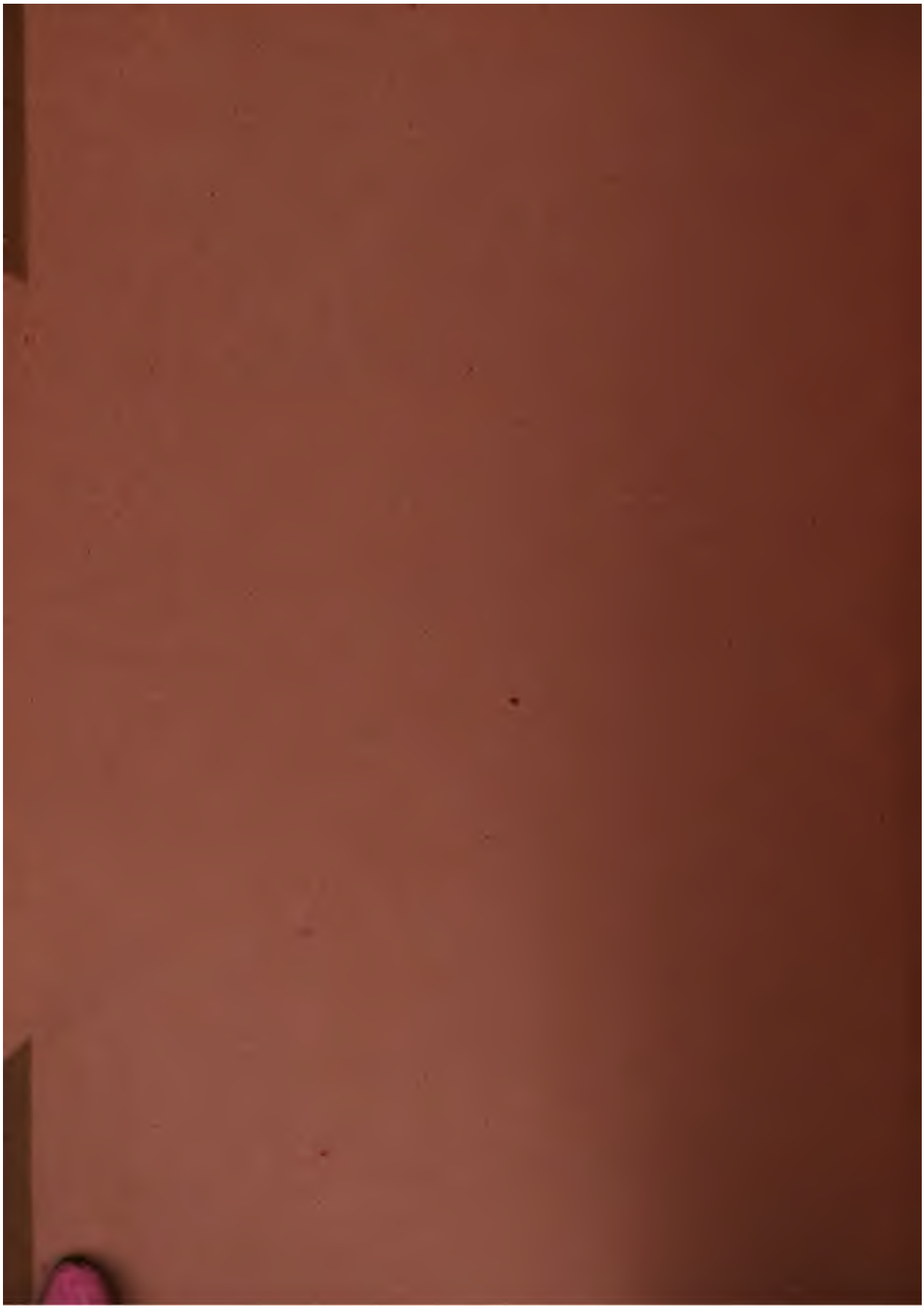

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